



Epidemiologic study of bladder and urethral injury in Korea: A nationwide population-based study

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Purpose: We aimed to analyze the characteristics and management of bladder and urethral injuries in Korea by use of the National Health Insurance Service (NHIS) database.

Materials and Methods: Data from the NHIS database representative of all cases of Korean bladder injury (n=4,631) and urethral injury (n=17,858) reported between 2012 and 2016 were analyzed. We used the International Classification of Diseases, 10th revision, clinical modification codes to identify the diagnoses.

Results: A total of 491 males (1.97/100,000) and 590 females (2.39/100,000) experienced bladder injury in 2012, and 449 males (1.76/100,000) and 624 females (2.47/100,000) in 2016. The risk of bladder injury was higher in female than in male (hazard ratio [HR], 1.267; p<0.001). The annual incidence of bladder injury did not increase (HR, 0.992; p=0.409). A total of 2,886 (62.3%) patients were managed with conservative treatment, and 1,745 (37.7%) patients underwent surgical treatment. A total of 4,114 males (16.5/100,000) and 285 females (1.2/100,000) had urethral injury in 2012, while 4,465 males (17.5/100,000) and 303 females (1.2/100,000) had urethral injury in 2016. The incidence of urethral injury is increasing annually (HR, 1.010; p=0.036).

Conclusions: The incidence of urethral injury increased continuously over the years studied, whereas that of bladder injury remained unchanged in Korea. The incidence of bladder injury was higher in females, and more than 90% of total urethral injuries were reported in males. This is the first study to evaluate the epidemiology of bladder and urethral injury using a nationwide population database.

Keywords: Urethra; Urinary bladder; Wounds and injuries

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INTRODUCTION

Genitourinary trauma is not a common type of injury. Such trauma not only causes urinary tract injury but also

damages other organs. In particular, injury to the urinary bladder and urethra, or the lower urinary tract, tends to be less frequent than upper urinary tract injury, and commonly occurs in conjunction with pelvic bone fracture or other

Received: 12 February, 2021 • **Revised:** 27 May, 2021 • **Accepted:** 30 September, 2021 • **Published online:** 1 December, 2021

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pelvic organ injuries [1]. However, in addition to trauma-induced injury, bladder injuries are caused by pelvic organ surgery, such as hysterectomy and colorectal surgery, and urethral injuries are related to benign prostatic hyperplasia and insertion of a Foley catheter in males.

Although the basic mechanisms of lower urinary tract injuries (LUTIs) have been known for several decades [2], the management of these injuries has changed. The development of endoscopy played a key role in the primary realignment of urethral injuries [3]; in addition, the increased application of laparoscopy in the urological field and the development of barbed sutures have popularized single-layer suturing for bladder repair [4,5]. Accurate treatment is important as incorrect treatment of LUTI can cause serious adverse effects such as urethral stricture, urinary tract infection, and urosepsis. Therefore, it is necessary to determine the incidence and treatment trends of LUTIs. However, accurate statistical data have not been reported in Korea.

Korea has established a national health insurance system; more than 99% of the nation's population receive health insurance, and all their records are accessible. However, the incidence or trend of bladder or urethral injury in Korea has not yet been reported. The present study aimed to analyze national data from the National Health Insurance Service (NHIS) database in South Korea reported between 2012 and 2016 and to document the gross occurrence and rate of bladder and urethral injury stratified by age, sex, and accompanying injuries or causes. In addition, the incidence of bladder and urethral injuries was quantified to evaluate whether the incidence changed over time. Our hypotheses were 1) the incidence of bladder and urethral injuries has increased over time; 2) the injuries may be related to pelvic bone fracture, but a difference might be observed according to the fracture site; and 3) there are differences from previous reports in Western countries as few gun accidents have occurred in Korea.

MATERIALS AND METHODS

1. Ethics statement

This study protocol was exempted from review by the Institutional Review Board of the Korea University Ansan Hospital (approval number: 2018AS0198) in accordance with the exemption criteria. The authors could not identify any of the included patients. Therefore, the need for informed consent was waived.

2. Data sources

A single mandatory health insurance system, also known

as the NHIS, has been adopted by the Korean government since 1989 and covers about 97% of the Korean population (approximately 50 million people). The other 3% of the population are supported by the Medical Aid Service, which is also funded by the Korean government for low-income people. We used data from the national health claims database of the NHIS of Korea [6]. Since 2006, information from the Medical Aid program has been integrated into a single NHIS database. Therefore, the NHIS claims database includes the actual claims data of the entire Korean population. The NHIS database consists of diagnoses, procedures, prescription records, and demographic information. We identified diagnoses using the International Classification of Disease, 10th revision, clinical modification codes.

3. Study population selection and definition

We stratified patients according to sex, age, and region. To investigate the incidence of urethral and bladder injury, we included patients who were diagnosed with bladder injury (S37.2X) or urethral injury (S37.3). To improve the diagnostic accuracy and avoid overestimation due to the inclusion of patients with injury to the lower urinary tract, we only included those with bladder injury or urethral injury with one or more diagnoses during hospitalization or two or more diagnoses in the outpatient clinic. In addition, to discount patients with ongoing treatment, we excluded those diagnosed with urethral and bladder injuries in 2011 who received related treatment during this period.

Comorbidities included age at the time of diagnosis of urethral or bladder injury; use of antiplatelet, anticoagulant, or statin medications; and a history of hypertension, myocardial infarction, congestive heart failure, peripheral vascular disease, type 1 or 2 diabetes mellitus, renal disease, or malignant neoplasm. Medication use and history of comorbidities were determined using the data collected 6 months before and after the diagnosis of LUTI.

Annual incidence was defined as the proportion of the population diagnosed with urethral or bladder injury within 1 year. It was expressed as a percentage of the population and was calculated by using the following formula: annual incidence (%) = number of patients with LUTI in a given period (1 year) ÷ number of people in the study sample during this period.

4. Statistical analysis

Chi-square tests were used to examine the differences in characteristics between the groups. A Poisson regression analysis was used to analyze the trend in the frequency of trauma occurrence (rate ratio). All statistical analyses were

Table 1. Characteristics, associated injuries, and management of patients with bladder trauma

Characteristic	Total injury
Sex	
Male	2,034 (43.9)
Female	2,597 (56.1)
Cause	
Trauma	3,454 (74.6)
Iatrogenic	1,177 (25.4)
Location	
Urban	3,487 (75.3)
Rural	1,144 (24.7)
Comorbidity	
Myocardial infarction	16 (0.3)
Congestive heart failure	58 (1.3)
Peripheral vascular disease	42 (0.9)
Cerebrovascular disease	256 (5.5)
Dementia	153 (3.3)
Chronic obstructive pulmonary disease	292 (6.3)
Rheumatic	41 (0.9)
Peptic ulcer	142 (3.1)
Mild liver disease	139 (3.0)
Diabetes mellitus	302 (6.5)
Diabetes mellitus with chronic complication	140 (3.0)
Hemiplegia	62 (1.3)
Renal disease	87 (1.9)
Severe liver disease	3 (0.1)
Metastatic solid	43 (0.9)
Management	
Conservative	2,886 (62.3)
Operative	1,745 (37.7)

Values are presented as number (%).

conducted using SAS (version 9.2; SAS Institute, Inc., Cary, NC, USA), and $p < 0.05$ was considered statistically significant.

RESULTS

1. Bladder injury

Between 2012 and 2016, a total of 4,631 patients experienced bladder trauma. Over 491 males (1.97/100,000) and 590 females (2.39/100,000) experienced bladder injuries in 2012, whereas 449 males (1.76/100,000) and 624 females (2.47/100,000) experienced this type of injury in 2016. The ratio of injuries in male to female was 43.9% to 56.1%, suggesting that the risk of bladder injury was higher in female than in male (Poisson regression; hazard ratio [HR], 1.267; 95% confidence interval [CI], 1.202–1.337; $p < 0.001$). The characteristics of the study participants are shown in Table 1. Diabetes mellitus was the most common comorbidity (6.5%) ac-

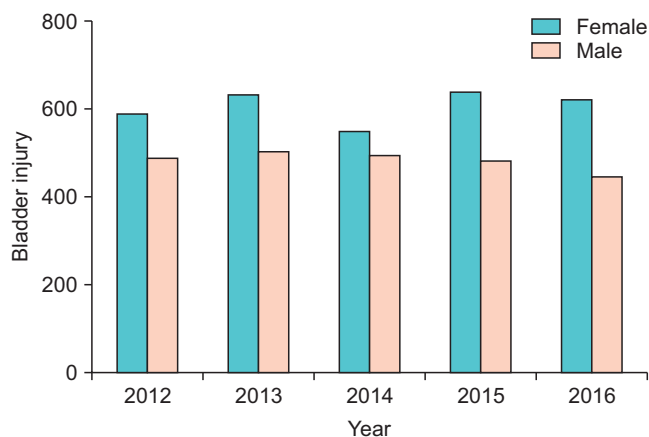


Fig. 1. Annual incidence of bladder injury in Korea. The risk of bladder injury was higher in female than in male (Poisson regression; HR, 1.267; 95% CI, 1.202–1.337; $p < 0.001$). However, the incidence of bladder injury did not increase every year (Poisson regression; HR, 0.992; 95% CI, 0.974–1.011; $p = 0.409$). HR, hazard ratio; CI, confidence interval.

companied by bladder injury, and one-quarter of all patients had an iatrogenic cause. During the observational period, the incidence of bladder injury did not consistently increase or decrease (HR, 0.992; 95% CI, 0.974–1.011; $p = 0.409$; Fig. 1). However, the prevalence of injuries in female remained high for 5 years. Approximately 62.3% ($n = 2,886$) of patients received conservative treatment, whereas 1,745 (37.7%) underwent surgical management.

Looking at each age group, the overall prevalence was higher in the 40- to 49-year-old and 50- to 59-year-old age groups (Fig. 2). However, a slight difference was noted according to sex; bladder injury commonly occurred in female in their 40s and in male in their 50s. In the below 30-year-old group and over 50-year-old group, the prevalence of bladder injury was higher in male than in female. In female, the 5-year cumulative incidence was higher in the 40- to 49-year-old group than in the other age groups.

When traumatic bladder injury was analyzed separately, 47.3% of the total cases were related to pelvic bone or hip fracture (Fig. 3). The injury frequently occurred in the pelvic circle, followed by the sacrum and coccyx (21.7% and 11.0%, respectively). Hip fracture was also significantly associated with bladder trauma, accounting for approximately 6.7% of all cases of noniatrogenic bladder trauma. Iatrogenic bladder injury was mostly caused by either general surgery, especially colon surgery (40.2%), or gynecological surgery (41.9%), including hysterectomy (22%) (Fig. 4). The percentage of cases associated with small-bowel surgery was quite high at 10.7%, and that associated with cesarean section was 1.5%, less than the expected rate.

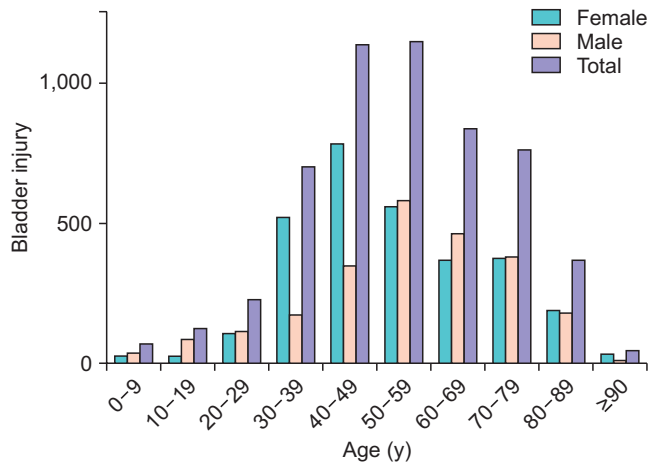


Fig. 2. Age distribution of bladder injury incidence in Korea, 2012–2016.

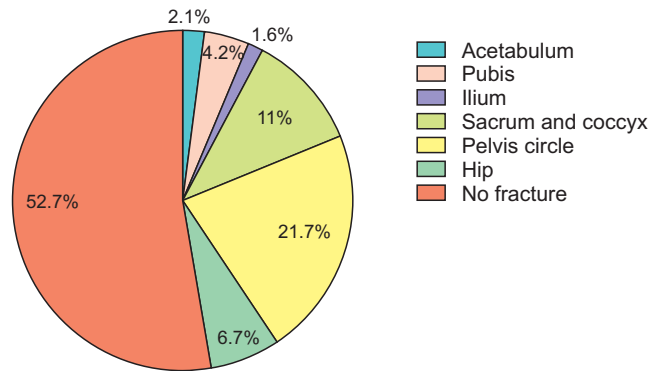


Fig. 3. Pelvic fracture configurations and associated bladder injuries (noniatrogenic).

2. Urethral injury

Between 2012 and 2016, a total of 17,858 patients experienced urethral trauma. More than 90% of total urethral trauma cases were reported in male (Fig. 5). Over 4,114 males (16.5/100,000) and 285 females (1.2/100,000) experienced urethral injuries in 2012; 4,372 males (17.3/100,000) and 292 females (1.2/100,000) in 2014, and 4,465 males (17.5/100,000) and 303 females (1.2/100,000) in 2016. The incidence of urethral injury tended to increase every year (HR, 1.010; 95% CI, 1.001–1.019; p=0.036). When we analyzed the number of cases of urethral damage that developed within 5 years, the results showed that the incidence was high in older patients, especially those aged ≥70 years (Fig. 6). About 90% these cases occurred along with other injuries, whereas 84% occurred along with abdominal and pelvic organ injuries (Fig. 7). Noniatrogenic urethral injury associated with pelvic bone fracture was reported in 10.1% of the patients, whereas testicular injuries associated with urethral injury were reported in 0.2% of the patients. Of the total patients with urethral injury, 19.8% underwent surgical treatment within

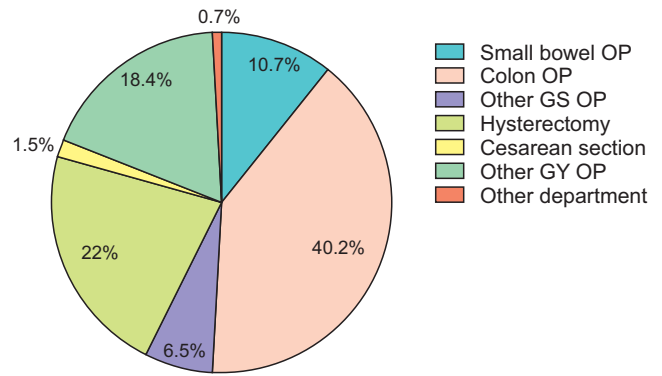


Fig. 4. Surgery related to bladder injury (iatrogenic). OP, operation; GS, general surgery; GY, gynecology.

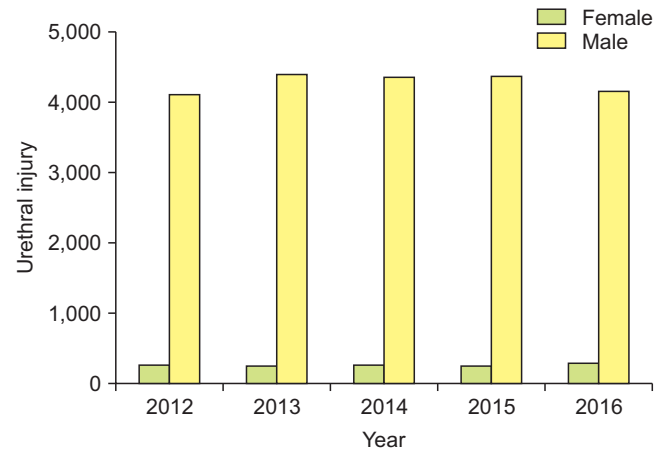


Fig. 5. Annual incidence of urethral injury in Korea.

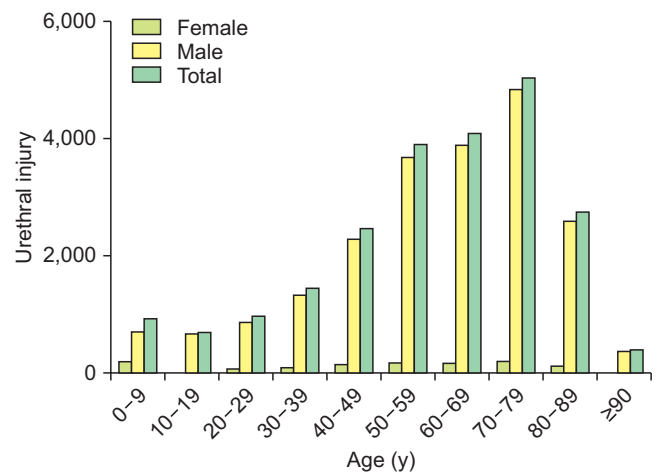


Fig. 6. Age distribution of the 5-year cumulative incidence of urethral injury.

a month; the most common surgical treatment provided was primary realignment or urethral dilation (58.1% in 2013 and 63.8% in 2016) (Fig. 8).

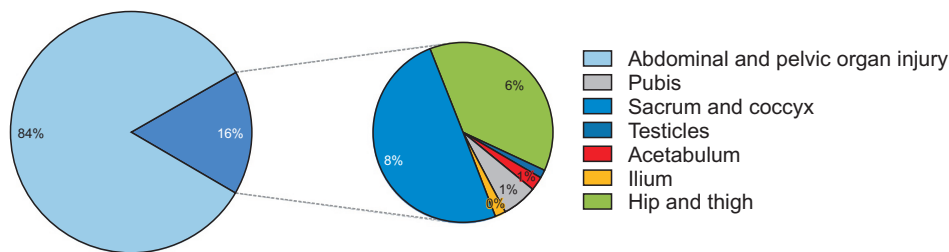


Fig. 7. Other injuries accompanying urethral injuries.

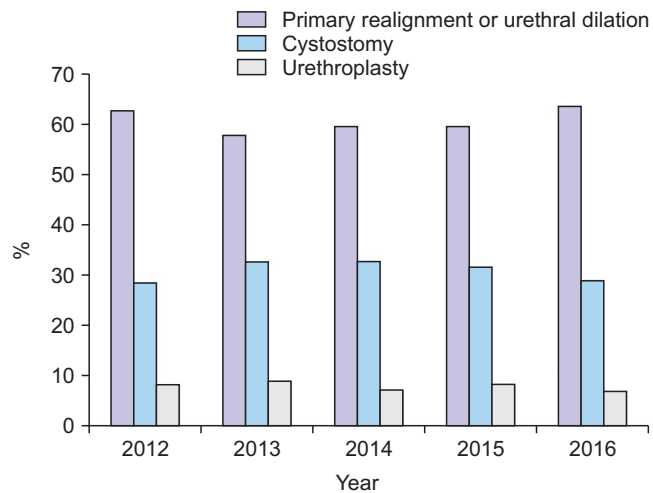


Fig. 8. Surgical management for urethral injury provided within 1 month.

DISCUSSION

We investigated the incidence of bladder and urethral injuries and their causes in Korea within a 5-year period. Overall bladder injury did not tend to increase over time, whereas bladder injury in female slightly increased. By contrast, the overall incidence of urethral injury gradually increased. As reported previously, urethral injury occurs more frequently in male than in female, but bladder injury occurs more frequently in female.

The major cause of LUTI is blunt trauma. Injuries to the bladder (60%–90%) and posterior urethra (75%) are mainly associated with pelvic fractures. Both bladder and urethral injuries occurred in 41% of the study participants. Trauma to the bulbar urethra is most commonly caused by a straddle injury. Injuries to the penile urethra are most frequently associated with penile fractures. Penetrating injuries, mostly gunshot wounds, can occur throughout the lower urinary tract, but are rare in the civilian setting. The incidence of bladder injury did not increase, whereas that of urethral injury increased. Urethral injuries are common in men which may be due to various Foley catheter-induced urethral injuries in older men. Urethral injuries may not be

considered a serious problem because they occur in only 3 of 1,000 catheterized patients [7]. However, in other countries, catheter-related urethral injury has been reported to cause several problems, such as urosepsis and acute renal failure, and contributes to increased medical costs [8]. In the era of the aging of the population, the incidence of iatrogenic urethral injury caused by insertion of catheters will likely continue to increase; therefore, countermeasures for this injury are urgently needed. Many efforts have been made to reduce catheter-related injuries [9].

Bladder injuries were found to be common among women in their 30s and 40s, and were most likely iatrogenic injuries caused by obstetrics and gynecology surgery. The bladder is one of the most commonly injured organs during an obstetric surgery, such as cesarean delivery or hysterectomy [10]. The probability of bladder injury among cesarean sections is reported to be 0.28%, and bladder injury occurs in 1.38% of patients undergoing laparoscopic vaginal hysterectomy [11,12]. As can be seen from our results, hysterectomy and cesarean section accounted for 22% and 15% of bladder injury cases, respectively. In particular, Korean women have a high preference for cesarean section; more than 40% of all births are performed through cesarean section, and maternal age and the incidence of placenta previa have also increased as a result of cesarean section [13]. In Korea, many obstetrics and gynecology surgeries are performed laparoscopically, and the possibility of bladder injury could be higher in laparoscopic surgery than in open surgery [12].

Although the incidence of genitourinary injuries is similar to the incidences of the three common types of pelvic fractures, certain fracture subtypes are known to place the genitourinary system at greater risk for injury, particularly straddle fractures. From a clinical perspective, the stability of a pelvic fracture is more useful in determining the likelihood of urethral injury. When pelvic fractures are categorized as stable, partially unstable, or unstable, the associated incidence of these fractures rises as the stability declines. In our results, pubis fractures were more frequent than acetabulum or ilium fractures, which are both pelvic bone fractures. Pelvic bone fractures are generally caused

by high-energy injuries, such as car accidents or falls, and patients with these fractures are at risk for bladder and urethral injuries [14]. Injuries caused by pelvic fracture are difficult to treat and tend to recur and cause recurrent strictures. According to the guidelines, primary realignment or suprapubic cystostomy is required in patients with urethral injury. It is recommended that urethroplasty be performed 3 to 6 months after urethral injury [14]. However, our study findings suggest that most of the surgical treatments after urethral injury were performed within 1 month of the injury, and most of the surgeries were primary realignment or urethral dilation. The frequency of primary urethroplasty within 1 month was very low. This may be because our research included not only urethral injuries caused by pelvic bone fractures, but also minor injuries caused by self-removal of a Foley catheter or catheterization-related iatrogenic injury. Iatrogenic urethral injury is commonly associated with the insertion of a urethral catheter [15,16]. In fact, urethral injury occurs more frequently in older patients. This is presumed to be because the chances of Foley catheter insertion increase as a result of hospitalization or surgery as age increases. In addition, because safety equipment and automobile safety have recently improved and the prevalence of negligent accidents has decreased, fewer injuries are caused by major accidents, and urethral injury itself has become relatively rare [17]. Nevertheless, the most common injuries associated with urethral injury, as revealed in this study, are abdominal and pelvic organ injuries; thus, we believe that the proportion of urethral injury due to traffic accidents remains high.

Our study has several limitations. First, it was difficult to determine the exact cause or severity of the injury because individual patient records were not reviewed. Hence, we relied on the prescription and diagnoses recorded in the NHIS database, which could lead to several errors and unintended results. Likewise, access to some information was limited; for example, in the case of iatrogenic injury, the exact cause was unknown. However, since most Koreans are covered by the NHIS, we believe that this is the first meaningful study to examine overall trends in urinary bladder and urethral injuries and their causes in Korea.

CONCLUSIONS

We reported the most recent incidences of bladder and urethral injuries in Korea using data from the national administrative database. Our data suggest that the incidence of urethral injury increased continuously throughout the years, whereas that of bladder injury remained unchanged.

The incidence of bladder injury is higher in female owing to pelvic surgeries, including hysterectomy. The incidence of urethral injury remained high owing to the increase in the proportion of older male, who commonly obtained these types of injuries. We believe that these findings will help to determine future trends in LUTI and the direction of treatment.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

ACKNOWLEDGMENTS

This research was supported by the Foundation for Korean Urological Association in 2019.

AUTHORS' CONTRIBUTIONS

Research conception and design: Bum Sik Tae, Young Eun Yoon, Jae Young Park, and Hong Sang Moon. Data acquisition: Bum Sik Tae, Young Eun Yoon, and Jae Young Park. Statistical analysis: Bum Sik Tae and Young Eun Yoon. Data analysis and interpretation: Bum Sik Tae and Young Eun Yoon. Drafting of the manuscript: Bum Sik Tae and Young Eun Yoon. Critical revision of the manuscript: Woong Na, Kyung Jin Oh, and Sung Yul Park. Obtaining funding: Jae Young Park and Hong Sang Moon. Administrative, technical, or material support: Woong Na, Kyung Jin Oh, and Sung Yul Park. Supervision: Hong Sang Moon. Approval of the final manuscript: Hong Sang Moon.

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