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# National Trends of Meniscectomy and Meniscus Repair in Korea

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## ABSTRACT

**Background:** Meniscus surgeries are frequently performed in orthopaedics. However, their current status is not well known in many countries, including Korea. This study aimed to investigate the national trends of meniscus surgery in Korea.

**Methods:** Information from the national database was acquired through the Korean Health Insurance Review and Assessment Service from 2010 to 2017. All cases coded as meniscectomy or meniscus repair were included. The total number and incidence of cases of meniscus surgery per 100,000 persons were determined, and the results were stratified by age and gender. The meniscus repair ratio for the total number of meniscus surgeries was evaluated.

**Results:** The total number and incidence of meniscectomy cases were 65,752 and 137, respectively, in 2010, which increased to 74,088 and 154, respectively, in 2017. The number of meniscectomies increased by 12.67% in 8 years. The total number and incidence of meniscus repair cases were 9,055 and 18, respectively, in 2010, which increased to 14,945 and 31 in 2017. The number of meniscus repairs increased by 65.04%. The meniscus repair ratio was 12.1% in 2010, which increased to 16.8% in 2017. The highest peak was noted for patients who underwent meniscus surgeries in their 50s and 60s. Meniscectomy was performed more frequently in women (57%) than in men (43%), whereas repair was performed more frequently in men (54%) than in women (46%) over the study period.

**Conclusion:** The total number and incidence of meniscus surgeries increased from 2010 to 2017; the number and incidence of meniscus repair procedures increased more rapidly than those of meniscectomy, with the peak treatment age for both surgeries being in the 50s and 60s. The current study will contribute to understanding the epidemiology of meniscus surgery, its prevention, and cost-saving measures in Korea.

**Keywords:** Meniscus; Meniscectomy; Meniscus Repair; Epidemiology; Incidence

## INTRODUCTION

The meniscus has several functions, including stabilization, shock absorption, tibiofemoral joint congruity, proprioception, and joint lubrication.<sup>1,2</sup> However, meniscus tears are one of the

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#### Disclosure

The authors have no potential conflict of interest to disclose.

#### Author Contributions

Conceptualization: Chung KS, Ha JK, Choi CH, Kim JG. Data curation: Kim YS, Wang PW, Ra HJ, Kong DH. Formal analysis: Kim JH. Investigation: Chung KS. Methodology: Chung KS. Writing - original draft: Chung KS. Writing - review & editing: Chung KS.

most common knee injuries and can be seen in all age groups.<sup>3,4</sup> Meniscus tears are associated with pain, articular cartilage degeneration, and instability of the knee joint.<sup>5</sup> The current treatment options for meniscus injury include nonoperative treatment, meniscectomy, repair, and meniscal allograft transplantation. Meniscectomy and meniscus repair are the traditionally recommended surgical procedures for meniscus injury, depending on the tear pattern, tear location, and meniscal condition. As meniscus-deficient knees are at a significantly increased risk of developing arthritic changes, meniscus repair is preferred to meniscectomy.<sup>6,7</sup>

Meniscus surgeries are one of the most commonly performed orthopaedic surgeries in the United States,<sup>8</sup> with a total of 387,833 meniscectomies and 23,640 meniscus repairs reported from 2005 to 2011.<sup>9</sup> The total number of isolated meniscus repairs performed increased significantly and the incidence of repairs doubled from 2005 to 2011. Although no significant increase was found in the total number of meniscectomies performed, the incidence of meniscectomies increased 14% from 2005 to 2011.<sup>9</sup> In Japan, a total of 34,966 meniscus surgeries were performed in 2015, with peaks among patients in their late teens and 60s. The meniscus repair ratio was 19% in 2014 and 24% in 2015.<sup>10</sup> Another Japanese study reported that the proportion of patients undergoing meniscus repair rose from 7.0% in 2007 to 25.9% in 2014, while that of patients undergoing meniscectomy fell from 92.8% in 2007 to 73.3% in 2014.<sup>11</sup>

This data is highly beneficial considering the critical role of national epidemiology in organizing the public health care system. However, the national epidemiologic data for meniscectomy and meniscus repair in Korea have not been reported.

The aim of the present study was to determine the national epidemiologic data for meniscus surgeries, including meniscectomy and meniscus repair, in Korea from 2010 to 2017 and to stratify the findings by age and gender, based on the analysis of the nationwide data acquired from the Korean Health Insurance Review and Assessment Service (HIRA). The authors hypothesized that the results would reflect an increase in the incidence of meniscus repairs.

## METHODS

In Korea, there is a legal obligation for inclusion of patient medical records in the HIRA database. Hence, surgery procedure codes in Korea are prospectively recorded in the HIRA data. The authors obtained and analyzed data related to procedure codes for meniscectomy and meniscus repair surgery in Korea from 2010 to 2017.

In the HIRA database, the meniscal surgery code is divided according to its complexity (simple or complex) and location (medial, lateral, or simultaneous medial and lateral tears). For meniscectomy, there are several surgery codes, including simple meniscectomy in the medial or lateral compartment (N0821), complex meniscectomy in the medial or lateral compartment (N0826), simple meniscectomy in both the medial and lateral compartments (N0822), and complex meniscectomy in both the medial and lateral compartments (N0827). With regard to the meniscectomy codes, there are no established criteria to distinguish simple and complex code selection; thus, it is necessary to combine these codes to investigate the total number of cases that underwent meniscectomy. For meniscus repair, there are several surgery codes, including simple meniscus repair in the medial or lateral compartment (N0823), complex meniscus repair in the medial or lateral compartment (N0828), simple meniscus repair in the medial and lateral compartments (N0824), and

**Table 1.** Surgical procedure codes including meniscectomy and meniscus repair in Korea

Surgery category	Procedure code	Description
Meniscectomy	N0821	Simple meniscectomy in medial or lateral
	N0826	Complex meniscectomy in medial or lateral
	N0822	Simple meniscectomy in medial and lateral
	N0827	Complex meniscectomy in medial and lateral
Meniscus repair	N0823	Simple meniscus repair in medial or lateral
	N0828	Complex meniscus repair in medial or lateral
	N0824	Simple meniscus repair in medial and lateral
	N0829	Complex meniscus repair in medial and lateral

complex meniscus repair in the medial and lateral compartments (N0829) (Table 1). All cases coded as meniscectomy or meniscus repair were included in this study.

The total number of cases per year and incidence of meniscus surgery per 100,000 person-years were investigated. Thereafter, a more detailed analysis was performed according to gender and age. Incidence per 100,000 person-years was based on additional information from the surveys including basic epidemiologic data as per the Korean National Statistics. The meniscus repair ratio was obtained by dividing the number of meniscus repairs by the total number of meniscus repairs plus the number of meniscectomies.

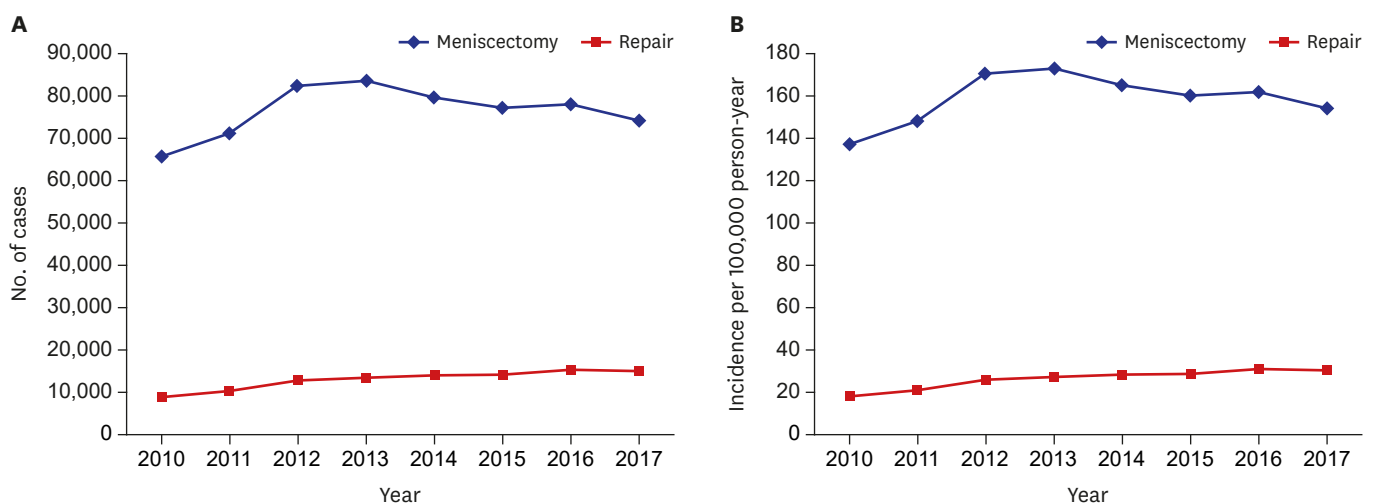
### Ethics statement

The present study protocol was reviewed and approved by the Institutional Review Board (IRB) of the Inje University Seoul Paik Hospital (approval No. PAIK 2018-08-005). The IRB waived the need for informed consent as all data are anonymous. Therefore, this study was performed without prior informed consent.

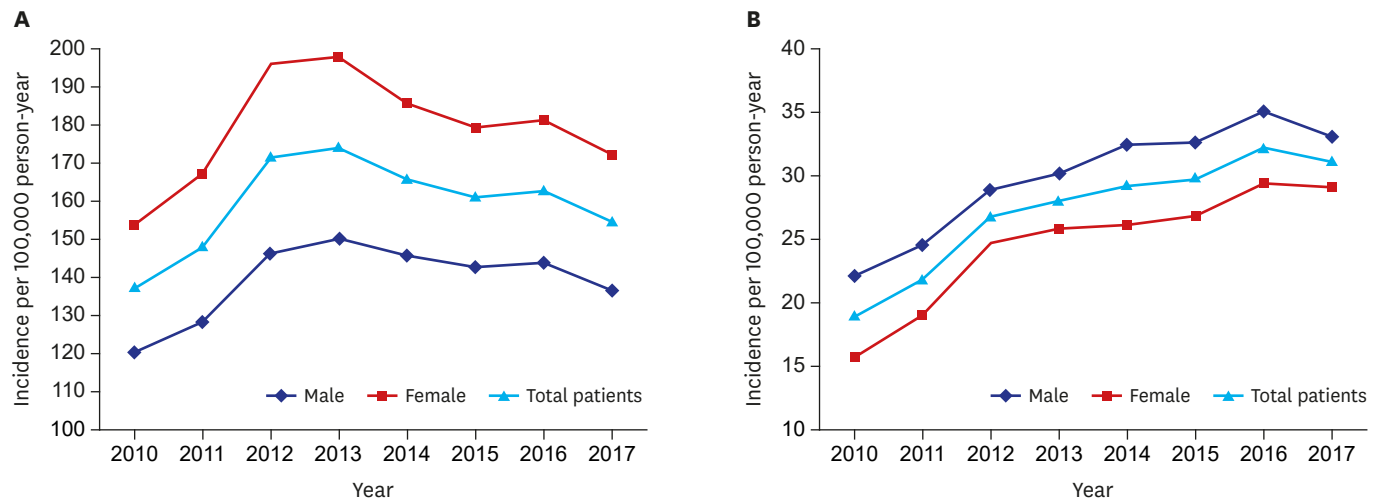
## RESULTS

### Meniscectomy

The total number of meniscectomies was 65,752 in 2010, which increased to 74,088 in 2017 (Supplementary Table 1 and Fig. 1A). The incidence per 100,000 person-years was 137 in



**Fig. 1.** Total number and incidence per 100,000 person-years of meniscectomy and meniscus repair cases per year in Korea. (A) Total number of cases, (B) Incidence per 100,000 person-years of cases.

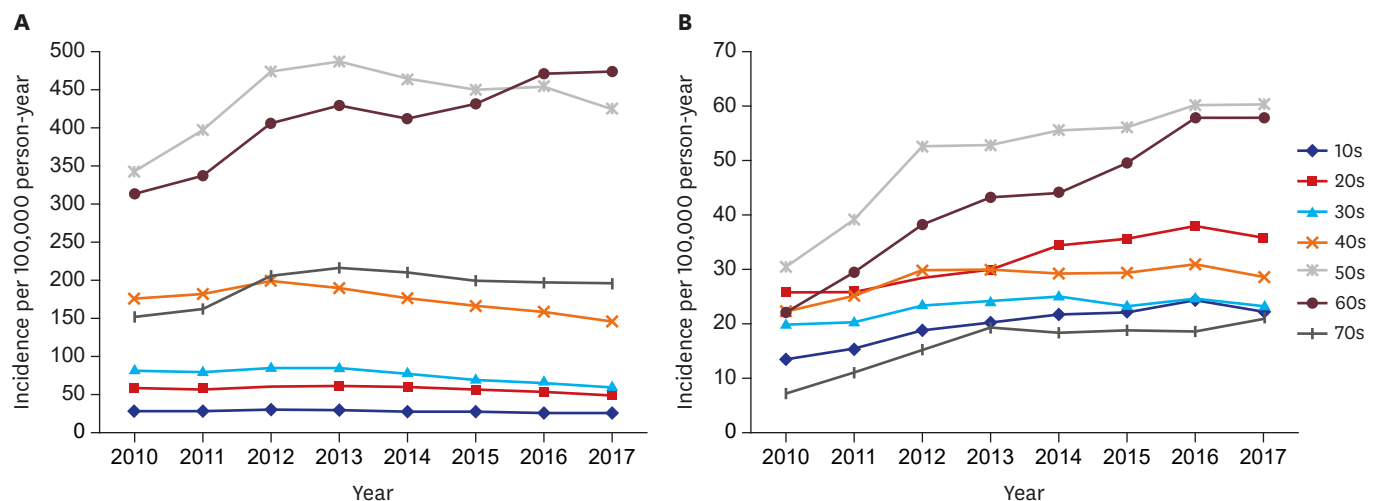


**Fig. 2.** Incidence per 100,000 person-years of meniscectomy or meniscus repair cases per year stratified by gender. (A) Meniscectomy cases, (B) Meniscus repair cases.

2010, which increased to 154 in 2017 (Supplementary Table 1 and Fig. 1B). The number of meniscectomies increased by 12.67% over this 8-year period.

Among men, the total number of cases and incidence per 100,000 person-years were 28,648 and 120, respectively, in 2010, which increased to 32,503 and 136, respectively, in 2017 (Supplementary Table 1 and Fig. 2A). Among women, the total number of cases and incidence per 100,000 person-years were 37,104 and 153, respectively, in 2010, which increased to 41,585 and 172, respectively, in 2017 (Supplementary Table 1 and Fig. 2A). Meniscectomy was more frequently performed among women than among men.

With regard to age, in 2017, the highest peak for the total number of cases was among patients in their 50s while that for incidence per 100,000 person-years was among patients in their 60s (Supplementary Table 1 and Fig. 3A). Conversely, the second highest peak for total number of cases was among patients in their 60s, while the second peak for incidence per 100,000 person-years was among those in their 50s (Supplementary Table 1 and Fig. 3A).



**Fig. 3.** Incidence per 100,000 person-years of meniscectomy or meniscus repair cases per year stratified by age. (A) Meniscectomy cases (B) Meniscus repair cases.

### Meniscus repair

The total number of meniscus repairs was 9,055 in 2010, which increased to 14,947 in 2017 (Supplementary Table 2 and Fig. 1A). The incidence per 100,000 person-years was 18 in 2010, which increased to 31 in 2017 (Supplementary Table 2 and Fig. 1B). The number of meniscus repairs increased by 65.04% over this 8-year period.

Among men, the total number of cases and incidence per 100,000 person-years were 5,265 and 22, respectively, in 2010, which increased to 7,884 and 33, respectively, in 2017 (Supplementary Table 2 and Fig. 2B). Among women, the total number of cases and incidence per 100,000 person-years were 3,790 and 15.70, respectively in 2010, which increased to 7,063 and 29.24, respectively, in 2017 (Supplementary Table 2 and Fig. 2B). Meniscus repairs were performed more frequently in men than in women.

The highest peak in 2017 was for patients in their 50s in terms of both total number of cases and incidence per 100,000 person-years (Supplementary Table 2 and Fig. 3B). The second highest peak was for patients in their 60s by both total number of cases and incidence per 100,000 person-years (Supplementary Table 2 and Fig. 3B).

### Meniscus repair ratio

The meniscus repair ratio was 12.1% in 2010, which increased to 16.8% in 2017 (Supplementary Table 3 and Fig. 4A). The meniscus repair ratios among men and women were 15.5% and 9.3%, respectively, in 2010, and increased to 19.5% and 14.5%, respectively, in 2017 (Supplementary Table 3 and Fig. 4A). The meniscus repair ratio was higher among men than that among women.

The meniscus repair ratios for patients in their 10s and 20s were 33.3% and 30.5%, respectively, in 2010, which increased to 48.8% and 42.0%, respectively, in 2017 (Supplementary Table 3 and Fig. 4B). The repair ratios for patients in their 50s and 60s were 8.2% and 6.6%, respectively, in 2010, and increased to 12.5% and 10.9%, respectively, in 2017 (Supplementary Table 3 and Fig. 4B). With regard to the repair ratio, the highest peak was for patients in their 10s and the second highest peak was for those in their 20s. The meniscus repair ratio showed a tendency to decrease with increase in age.

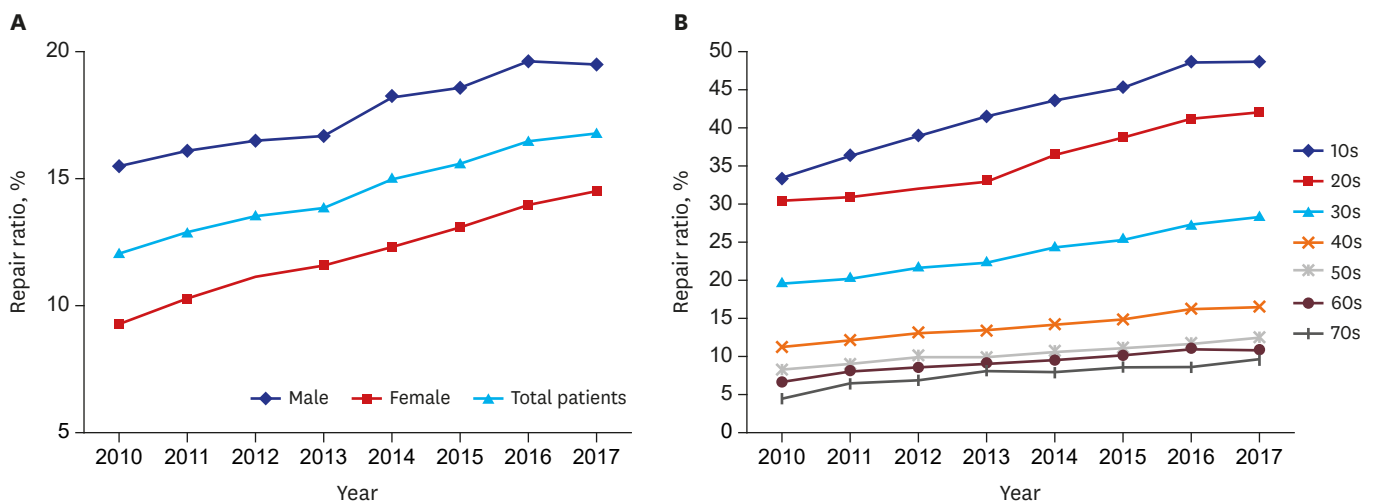


Fig. 4. Repair ratio in meniscus surgeries per year stratified by gender or age. (A) Gender, (B) Age.

## DISCUSSION

The important findings of this study were as follows: 1) the total number of cases of meniscectomy and incidence per 100,000 person-years were 74,088 and 154, respectively, in 2017, which increased by 12.67% during the study period; 2) the total number of cases of meniscal repair and incidence per 100,000 person-years were 14,945 and 31, respectively, in 2017, which increased by 65.04% during the study period; 3) meniscectomy was performed more frequently in women than in men, whereas meniscus repairs were performed more frequently in men than in women; 4) the meniscus repair ratio increased from 12.1% to 16.8% during the study period, and was higher in men than that in women; and 5) the highest peak was for patients who received meniscus surgeries in their 50s and 60s.

Meniscus surgeries are one of the most commonly performed orthopaedic surgeries<sup>8</sup>; thus, the national trends and epidemiology of meniscus surgeries are critical for future planning and national policy development. There are a few reports of the national trends and epidemiology of meniscus surgeries around the world.<sup>9,10</sup> To the best of our knowledge, this is the first study to report the national trends of meniscus surgeries, including meniscectomy and meniscus repair, in Korea.

A total of 65,752 meniscectomies were performed in 2010, which increased to 74,088 in 2017. The incidence per 100,000 person-years was 137 in 2010, which increased to 154 in 2017. The number of meniscectomies increased by 12.67% over this 8-year period. In the United States, 387,833 meniscectomies were performed from 2005 to 2011, and 54,110 were performed in 2011 alone.<sup>9</sup> The incidence of meniscectomy increased only 14% from 2005 to 2011.<sup>9</sup> In Japan, the number of meniscectomies was approximately 28,558 in 2014 and 26,519 in 2015.<sup>10</sup> When considering the total population, the assumed incidence of meniscectomy per 100,000 was about 17 in the United States (2011) and 22 in Japan (2015), whereas that in Korea was 154 (2017). Although, the data reflect the incidence for different years, it appears that meniscectomies were performed more commonly in Korea than in the United States and Japan. Data from the HIRA database in Korea is considered as highly accurate national data because all medical records, including surgery codes, are included in the HIRA data as per the guidelines of the national government, unlike data from other countries. Nevertheless, the incidence of meniscectomy in Korea is assumed to be higher than that in other countries. Korea has a national insurance system that covers all Korean patients with a relatively low cost for meniscus surgeries and provides easy access to orthopaedic hospitals. These are the likely contributing factors to the higher incidence of meniscectomy in Korea. However, the total number of cases and incidence of meniscectomy has begun to decrease from 2014. We attribute this to the strict review of surgical procedures and indications by HIRA. In the future, several measures can be considered to decrease the incidence of meniscectomy, including 1) increasing surgical fees so that surgeries are not forced, 2) forcing a certain period of conservative treatment before performing surgical procedures, and 3) more strict review of surgical procedures by HIRA.

With regard to age, in 2017, the highest peak for the total number of meniscectomy cases was for patients in their 50s and the highest peak for the incidence per 100,000 person-years was for those in their 60s. The reverse was true for the second highest peak. In Japan, the highest peak for meniscectomy cases was for patients in their 60s and the second highest peak was for those in their 50s.<sup>10</sup> In the United States, the peak age for meniscectomy was between 45 and 54 years and the second highest peak was between 55 and 64 years.<sup>9</sup> These are similar to our results in Korea.



In terms of meniscus repair, a total of 9,055 cases were performed in 2010, which increased to 14,947 in 2017. The incidence per 100,000 person-years was 18 in 2010 and increased to 31 in 2017. The number of meniscus repairs rapidly increased by 65.04% over this 8-year period. In the United States, there were a total of 23,640 meniscus repairs from 2005 to 2011, and 3,561 meniscus repairs were performed in 2011, representing an increase of only 11%.<sup>9</sup> In Japan, the number of meniscus repairs was approximately 6,769 in 2014 and 8,447 in 2015.<sup>10</sup> When considering the total population, the assumed incidence of meniscus repairs per 100,000 was about 1.2 in the United States (2011) and 7 in Japan (2015), whereas the incidence per 100,000 was 31 in Korea (2017). Despite the difference in the time frame of the data, meniscus repairs appear to be more common in Korea than those in the United States and Japan, possibly owing to similar reasons as stated above for meniscectomy. The significant difference in the incidence of meniscus repairs between Korean and the United States in particular, seems to imply a greater preference for meniscus repairs among surgeons in Korea than among those in the United States.

With regard to age, in 2017, the highest peak was for patients in their 50s in terms of both total number of cases and incidence per 100,000 person-years, while the second highest peak was for patients in their 60s. Conversely, the highest peak was for patients in their 10s and the second highest peak was for patients in their 20s in Japan.<sup>10,11</sup> In the United States, the peak age was less than 25 years old and the second peak was between 25 and 34 years.<sup>9</sup> These differ from the results in Korea. The authors assume that one probable reason for the difference is that there are many patients with potentially repairable meniscal tears and Korean surgeons are more likely to try a meniscus repair even in middle-aged patients with degenerative tears.

However, the ratio of repair in Korea increased over the 8-year study period from 12.1% in 2010 to 16.8% in 2017, and the highest peak was for patients in their 10s followed by a second peak for patients in their 20s. The meniscus repair ratios for patients in their 10s and 20s were 48.8% and 42.0%, respectively, in 2017, whereas those for patients in their 50s and 60s were 12.5% and 10.9%, respectively. Thus, the meniscus repair ratio showed a tendency to decrease as age increased. Kawata et al.<sup>11</sup> reported that the proportion of patients undergoing meniscus repair rose from 7.0% in 2007 to 25.9% in 2014, and the highest peak was noted for patients in their 10s while the second highest peak was noted for patients in their 20s. Katano et al.<sup>10</sup> reported that in Japan, the repair ratio was 19% in 2014 and 24% in 2015, and the highest peak in both years was for patients in their late teens. The repair ratio for patients in their late teens was 46% in 2014 and 51% in 2015, whereas it was only 7% for patients in their early 60s in 2014 and patients in their late 60s in 2015.<sup>10</sup> These results are similar to those of the Korean data. In the United States, the repair ratios for patients less than 25 years old and those between 24 and 34 years old were 27% and 14%, respectively, in 2011, whereas they were only 1.65% and 0.6% for patients between 45 and 54 years old and those between 55 and 64 years old, respectively. According to these results in three countries, there is an inverse relationship between repair ratio and patient age, with the ratio decreasing as age increases. Furthermore, meniscectomy, rather than meniscus repair, was generally selected if surgery was required for middle-aged and older patients. However, the repair ratio was higher in both Korea and Japan than in the United States, for all ages. In particular, there was a much higher repair ratio for middle-aged and older patients in Korea than the United States. As previously noted, it is assumed that Korean surgeons are more likely to treat degenerative meniscal tears in middle-aged and older patients. In Korea, there are many middle-aged and older patients with meniscus root tears and interest in root repair has been increasing.<sup>12</sup> Meniscus

root tears can lead to loss of hoop tension, and pathologic loads can lead to degenerative arthritis.<sup>13-17</sup> Root repair can restore meniscal hoop tension and slow arthritic progression in most cases.<sup>18-21</sup> We assume this to be one of the reasons for higher meniscus repair ratio in Korea than that in the United States among middle-aged and older patients.

With regard to gender, in Korea, meniscectomy was performed more frequently in women (57%) than in men (43%), whereas, meniscus repair was performed more frequently in men (54%) than in women (46%) during the 8-year study period. This is because of higher proportion of meniscectomies than meniscus repairs, and relatively larger number of woman patients than man patients in receiving meniscectomies. However, according to a study in the United States from 2004 to 2009, gender differences were more pronounced for meniscus repair (63% men vs. 37% women) than those for meniscectomy (53% men vs. 47% women).<sup>22</sup> Similarly, according to another American study, meniscectomy (57% men vs. 43% women in 2011) and meniscus repair (60% men vs. 40% women in 2011) were performed more frequently in men than in women in the United States.<sup>9</sup> In Japan, all meniscus surgeries, including meniscectomy and repair, were performed more frequently in men (52%) than in women (48%) over an 8-year period.<sup>11</sup>

Complex procedure codes for meniscus repairs, which can be coded as a repair of root or radial tear, have been newly developed in 2014 (**Supplementary Fig. 1**). However, with regard to meniscectomy, there is no need to distinguish between simple and complex codes because the criteria to distinguish between the two do not exist. In other words, the same codes are used for both simple and complex meniscectomies in the HIRA data.

The current study did not include a statistical analysis and did not evaluate the statistical significance because this study was based on an entire database, instead of a small sample size. In any experiment or observation that involves drawing a sample from a population, observed results from small sample may be generalizable to the entire population by statistical analysis. However, there was no need to conduct such statistical analysis in this study.

There are several strengths of the current study. This is the first report to investigate the national trends of meniscus surgeries based on a national database in Korea. This national database is one of the most accurate national data sources worldwide because it covers the entire Korean population, includes all medical records, and is under the control of the Korean government.

However, there are also several limitations to this study. First, there is the possibility of coding errors in a large database. Second, the cases that underwent meniscus surgery in our analysis did not include subjects injured in traffic accidents, industrial accidents, or those who made claims for automobile liability insurance or industrial injury insurance; however, there are potentially much fewer of those cases than those in which data are recorded in the HIRA database. Third, the meniscus surgery numbers we analyzed included only meniscus surgery coding; thus, other concomitant knee surgeries could not be investigated. Fourth, cases with bilateral meniscus procedures could not be identified, because this study was based on a large scale database. Thus, this study presented the number of cases, and not the number of patients.

In conclusion, although the total number of cases and incidence of meniscus surgeries both increased from 2010 to 2017, the number and incidence of meniscus repair procedures



increased more rapidly than those of meniscectomy, with the peak treatment age for both surgeries being in the 50s and 60s. The current study will contribute to understanding the epidemiology of meniscus surgery, its prevention, and cost-saving measures in Korea.

## SUPPLEMENTARY MATERIALS

### Supplementary Table 1

Number of cases, incidence, and information stratified gender and age for meniscectomy from 2010 to 2017

[Click here to view](#)

### Supplementary Table 2

Number of cases, incidence, and information stratified gender and age for meniscus repair from 2010 to 2017

[Click here to view](#)

### Supplementary Table 3

Results of repair ratio (%) from 2010 to 2017

[Click here to view](#)

### Supplementary Fig. 1

Total number of meniscectomy or meniscus repair cases per year according to procedure codes in Korea. (A) Meniscectomy cases, (B) Meniscus repair cases.

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