Trends in Surgical Treatment of Femoral Head Osteonecrosis in South Korea: An Analysis Using Nationwide Claims Database

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Background: Osteonecrosis of the femoral head (ONFH) involves young or middle-aged adults, and its incidence is increasing along with increasing use of steroids in the management of organ transplantation and adjuvant therapy for malignant neoplasms. To date, no pharmacological agent has been proven to prevent or retard the progression of ONFH, and surgical procedures including joint preservation procedures and hip arthroplasties are main treatments for the disease. Although ONFH is the most common or second most common disease for hip arthroplasty in East Asian countries, the trend of surgical procedures in this region remains unknown. Thus, we evaluated trends in surgical treatment of the disease in South Korea.

Methods: We identified patients with ONFH from the Korean Health Insurance Review and Assessment (HIRA) database, a nationwide medical claims database of South Korea, between January 2007 and December 2018 and calculated the proportions of following surgical procedures at each year: total hip arthroplasty (THA), hemiarthroplasty (HA), core decompression/multiple drilling, femoral osteotomy, and vascularized bone grafting.

Results: The total number of procedures increased from 3,824 in 2007 to 6,929 in 2018. Overall, the rate of THA (86%) was far greater than other procedures. From 2007 to 2018, the percentage of THA among the procedures increased from 80% to 91%, while that of joint preservation procedures decreased from 11% to 5%.

Conclusions: The total number of surgical procedures performed for ONFH increased and the percentage of THA increased, while that of joint preservation procedures decreased from 2007 to 2018 in South Korea.

Keywords: Hip, Osteonecrosis, Avascular necrosis, Therapy, Trends

Osteonecrosis of the femoral head (ONFH) is a disease that frequently leads to collapse of the femoral head and subsequent arthritis of the hip. In the United States, the annual incidence of the disease was reported to be 15,000 to 20,000.1,2 In East Asian countries, it is the most common or second most common disease for hip arthroplasty. More than 10,000 patients are affected by the disease yearly in South Korea, and the annual incidence rate is 1.91/100,000 in Japan.3,4 Most ONFH patients in an advanced stage eventually necessitate total hip arthroplasties.
The disease accounts for more than 10% of the overall THAs in the United States and around 50% in East Asia and sub-Saharan Africa.

The etiology of ONFH is multifactorial including genetic predispositions, as well as exposure to risk factors. Hereditary thrombophilia/hypofibrinolysis and impaired angiogenesis have been known to be implicated in the pathogenesis of the disease. Two of the most common risk factors are the use of steroids and excessive alcohol consumption. Various medical and surgical treatment options have been implemented based on the pathogenic mechanism. Even though several pharmacological agents such as bisphosphonates, enoxaparin, statins, iloprost, and acetylsalicylic acid have been adopted to alleviate the progression of ONFH, none of them was proven to be effective by high level of evidence.

Operative treatments include (1) joint preservation procedures such as core decompression, multiple drilling, vascularized bone grafting, and proximal femoral osteotomies and (2) hip arthroplasties such as THA and hemiarthroplasty (HA). The joint preservation procedures are tried in early stages of ONFH while patients in an advanced stage are mainly treated with hip arthroplasties. Several studies have reported trends in surgical treatment of ONFH in the United States. Nevertheless, there is a lack of study reporting the trends in East Asia, where the disease is the leading cause of hip arthroplasties. The purpose of this study was to reveal the trends in surgical treatment of ONFH in South Korea using nationwide medical claims database.

**METHODS**

The present study was exempted from institutional review board approval because it did not involve human subjects. Medical data from both the KNHIP and the medical aid program are submitted to HIRA for reimbursement. Medical information including patient demographics, diagnoses, procedures, and prescriptions stratified by International Classification of Diseases-10 (ICD-10) codes and Electronic Data Interchange codes is available through the HIRA database.

**Database**

The Korean Health Insurance Review and Assessment (HIRA) database was used in this registry study. Ninety-seven percent of Korean citizens are covered by the Korea National Health Insurance Program (KNHIP), while the remaining 3% are supported by the South Korean government through a medical aid program. Medical data from both the KNHIP and the medical aid program are submitted to HIRA for reimbursement. Medical information including patient demographics, diagnoses, procedures, and prescriptions stratified by International Classification of Diseases-10 (ICD-10) codes and Electronic Data Interchange codes is available through the HIRA database.

**Statistical Analysis**

Patients who were admitted due to ONFH from January 2007 to December 2018 were identified via ICD diagnosis codes (M8705, M8715, M8725, M8735, M8785, M8795, M9035, M9045, and M9055). Patients younger than 20 years were excluded because the disease is very rare in this population. Then, the procedural codes to treat ONFH patients were analyzed. The annual number of each procedure and its crude incidence (the procedural number/year-specific population) were calculated. The annual population data of South Korea were obtained from the Korean Statistical Information Service. Age-adjusted procedural data were obtained from men and women separately. Data analysis was carried out using R software (version 3.5.3; R Foundation, Vienna, Austria). Fisher’s exact test was used to compare the proportions.
used to compare proportional differences between various groups. Probability values of 0.05 were considered significant for all analyses.

**RESULTS**

Procedures for ONFH during the study period were THA (N0711, N2070), HA (N0715, N2710), multiple drilling (N0021), femoral osteotomy (N0302, N0305), and vascularized fibular grafting (VFG; N1583, N1584, N1585). The total number of patients who underwent those procedures from 2007 to 2018 was 68,085. The annual number of total procedures increased from 3,824 in 2007 to 6,929 in 2018. The most common procedure was THA (86%), followed by multiple drilling, HA, femoral osteotomy, and VFG. The percentage of THA among all procedures increased from 80% to 91%, while that of joint preservation procedures decreased from 11% to 5% (Table 1, Fig. 1).

![Fig. 1. Annual number of procedures for osteonecrosis of the femoral head from 2007 to 2018 in South Korea. THA: total hip arthroplasty, HA: hemiarthroplasty, MD: multiple drilling, FO: femoral osteotomy, VFG: vascularized fibular graft.](image)

**Table 2. Sex and Age of Patients Who Underwent Surgery for ONFH between 2007 and 2018**

| Surgery | THA     | HA       | FO       | VFG   | MD       |
|---------|---------|----------|----------|-------|----------|
| Total number | 58,475 (86) | 4,591 (7) | 217 (0.3) | 82 (0.1) | 4,720 (7) |
| Sex     |         |          |          |       |          |
| Female  | 18,263  | 1,707    | 49       | 15    | 1,077    |
| Male    | 40,212  | 2,884    | 168      | 67    | 3,643    |
| Age (yr) |         |          |          |       |          |
| Mean ± SD | 55.4 ± 13.2 | 59.5 ± 14.3 | 40.8 ± 13.1 | 37.7 ± 8.4 | 47.4 ± 11.9 |
| Range   | 20–98   | 20–95    | 20–83    | 20–61 | 20–92    |
| Age group (yr) |         |          |          |       |          |
| 20–29   | 1,601   | 65       | 51       | 15    | 322      |
| 30–39   | 5,839   | 335      | 56       | 33    | 966      |
| 40–49   | 11,652  | 811      | 51       | 29    | 1,380    |
| 50–59   | 16,893  | 1,097    | 41       | 4     | 1,342    |
| 60–69   | 13,060  | 978      | 14       | 1     | 553      |
| 70–79   | 8,038   | 957      | 3        | 0     | 140      |
| ≥ 80    | 1,392   | 348      | 1        | 0     | 17       |

ONFH: osteonecrosis of the femoral head, THA: total hip arthroplasty, HA: hemiarthroplasty, FO: femoral osteotomy, VFG: vascularized fibular graft, MD: multiple drilling, SD: standard deviation.
Male preponderance was found in all of the five procedures and the mean age of the patients at the time of procedure was 55.5 ± 14.3 years (range, 20–99 years). Patients undergoing HA or THA were older than those undergoing multiple drilling, femoral osteotomy, or VFG (Table 2). During the study period from 2007 to 2018, the number of THAs nearly doubled, while the numbers of HAs and multiple drillings did not change significantly and the numbers of femoral osteotomies and VFGs decreased (Fig. 2).

The crude incidence of THA increased ($p < 0.001$), while that of other procedures decreased during the study period (Fig. 3). This trend did not change even after age adjustment (Fig. 4). The most common age group undergoing THA or HA was 50–59 years, while joint preservation procedures were done in younger patients. VFG was not performed at all in 2018 (Fig. 5).

**DISCUSSION**

Our study showed that the total number of procedures performed for ONFH nearly doubled from 3,824 to 6,929, and the proportion of THA increased from 80% (3,058/3,824) to 91% (6,305/6,929), while that of joint preservation procedures decreased from 11% to 5% during the period from 2007 to 2018 in South Korea. Similar trends were found in the United States. In a registry study using Nationwide Inpatient Sample data between 1992 and
2008, Johnson et al. reported that the number of total procedures for ONFH increased twice and the percentage of THA increased from 76% to 88%, while that of joint preservation procedures decreased from 25% to 12%. A Japanese multicenter study showed a twofold increase in the number of THA and approximately 45% decrease in that of osteotomy between 2003 and 2017.

The growing proportion of THA in the treatment of the disease is due to excellent outcome and survivorship of THAs using durable bearing surfaces of contemporary ceramic composites or highly cross-linked polyethylene. Mid- to long-term studies of THAs using these bearings showed over 95% survival rates and excellent functional outcomes. In our study, the proportion of joint preservation procedures decreased by more than 50% during the study period.

The criteria for choosing surgical procedures are mainly based on the size, location, and collapse of the ONFH lesion. Core decompression and multiple drilling have been used in early-stage (pre-collapse) ONFH with the assumption that it prevents or reverses the disease progression. Recently, injection of bone marrow aspirate concentration is used to improve results. However, the results of these procedures were not consistent, and the effectiveness was questioned. Femoral osteotomies and vascularized bone grafts are criticized due to the technical difficulties and unfavorable outcomes.

Our study was based on HIRA data, which has inherent limitations due to de-identification and lack of detailed information. Erroneous coding might have compromised the accuracy of the database study. However, the strength of this study is that it covers nearly 100% of all procedures for ONFH in South Korea. Furthermore, as the counted event in the analysis was the surgery rather than the patient, there were duplications such as bilateral operations or multiple operations such as prior multiple drilling and subsequent THA.

In conclusion, the number of surgical procedures for ONFH markedly increased from 2007 to 2018 in South Korea. THA accounted for 86% and nearly doubled in number, while the percentage of joint preservation procedures decreased from 11% to 5% during the period.

**CONFLICT OF INTEREST**

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

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