



## Current status of and trends in post-mastectomy breast reconstruction in Korea

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Since April 2015, post-mastectomy breast reconstruction has been covered by the Korean National Health Insurance Service (NHIS). The frequency of these procedures has increased very rapidly. We analyzed data obtained from the Big Data Hub of the Health Insurance Review and Assessment Service (HIRA) and determined annual changes in the number of breast reconstruction procedures and related trends in Korea. We evaluated the numbers of mastectomy and breast reconstruction procedures performed between April 2015 and December 2018 using data from the HIRA Big Data Hub. We determined annual changes in the numbers of total, autologous, and implant breast reconstructions after NHIS coverage commenced. Data were analyzed using Microsoft Excel. The post-mastectomy breast reconstruction rate increased from 19.4% in 2015 to 53.4% in 2018. In 2015, implant reconstruction was performed in 1,366 cases and autologous reconstruction in 905 (60.1% and 39.8%, respectively); these figures increased to 3,703 and 1,570 (70.2% and 29.7%, respectively) in 2018. Free tissue transfer and deep inferior epigastric perforator flap creation were the most common autologous reconstruction procedures. For implant-based reconstructions, the rates of direct-to-implant and tissue-expander breast reconstructions (first stage) were similar in 2018. This study summarizes breast reconstruction trends in Korea after NHIS coverage was expanded in 2015. A significant increase over time in the post-mastectomy breast reconstruction rate was evident, with a trend toward implant-based reconstruction. Analysis of data from the HIRA Big Data Hub can be used to predict breast reconstruction trends and convey precise information to patients and physicians.

**Keywords** Breast neoplasms / Mammoplasty / Statistics / Insurance / Big data

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### INTRODUCTION

A total of 221,347 new cancers and 82,344 deaths from cancer

were predicted to occur in Korea in 2019 based on data from the Korea Central Cancer Registry and the Korea National Cancer Incidence Database from 1993 to 2018. In 2019, breast

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cancer was predicted to account for 23.8% ( $n = 24,010$ ) of all cancers in women, a value almost four times higher than that of 20 years ago. Currently, breast cancer is the most common malignancy in women [1]. Although the cause of the increased incidence of breast cancer remains unclear, an increase in the total duration of estrogen exposure is associated with consumption of a Westernized diet, obesity, late marriage, a low fertility rate, decreased breastfeeding, early menarche, and late menopause [2]. Deaths from breast cancer in 2019 were expected to account for 8.5% of deaths ( $n = 2,719$ ) from all cancers in women. The mortality rate of breast cancer is relatively low compared to those of other cancers, likely due to early cancer detection by Korea National Breast Cancer Screening Program [3].

The incidence of partial mastectomy (27.9% in 2000) has steadily increased, overtaking total mastectomy in 2006 and reaching 67.2% by 2012. The rate of partial mastectomy fell to 64.9% in 2014 and 61.6% in 2016, while the rate of total mastectomy rose to 34.0% in 2014 and 37.0% in 2016. The partial mastectomy rate has been decreasing since 2013, as advanced breast cancer requires total mastectomy, and developments in imaging modalities such as magnetic resonance imaging have facilitated the diagnosis of less advanced breast cancers [2].

For breast cancer patients, breast reconstruction affords esthetic and psychological benefits and improves quality of life [4,5]. Despite these benefits and a recent increase in favorable perceptions of breast reconstruction, the high cost of surgery and the lack of insurance coverage constitute major barriers to breast reconstruction after mastectomy. In the United States, the Women's Health and Cancer Rights Act (WHCRA), which mandates insurance coverage of all post-mastectomy breast reconstructions, was signed into law in October 1998 and enacted in January 1999 [6].

The South Korean health insurance system is a public single-payer system; healthcare providers are automatically eligible for this system and must treat patients using covered healthcare services. The private sector invests in the system, but the government controls it [7]. Breast reconstruction after total mastectomy has been covered by the National Health Insurance Service (NHIS) since April 2015, at which point the Health Insurance Review and Assessment Service (HIRA) began to collect comprehensive data on breast reconstructions. This policy change encouraged breast reconstruction after total mastectomy, and over half of all mastectomy patients underwent breast reconstruction in 2018.

We explored the status of and trends in post-mastectomy breast reconstruction after insurance coverage was initiated in 2015 by analyzing data stored in the HIRA Big Data Hub. By doing so, we created a standardized data profile of breast recon-

struction in Korea.

## METHODS

We evaluated the numbers of mastectomy and breast reconstruction procedures performed between April 2015 and December 2018. The study was approved by the Institutional Review Board of Soonchunhyang University Hospital. We were provided online access to the HIRA Big Data Hub, and we collected data using the procedural codes for mastectomy and breast reconstruction from the Korean Standard Classification of Diseases, seventh revision. Autologous breast reconstruction was classified as LD, PTRAM, or FTRAM (defined below). The flaps employed included latissimus dorsi (LD) muscle flaps, muscle-sparing LD myocutaneous flaps (thoracodorsal artery perforator flaps), and extended LD myocutaneous flaps. The PTRAM category included both single-pedicled transverse rectus abdominis musculocutaneous (TRAM) flaps and bipedicled TRAM flaps. The FTRAM category included free TRAM flaps, muscle-sparing FTRAM flaps, and deep inferior epigastric artery perforator (DIEP) free flaps. Implant breast reconstruction was classified as either tissue expander (TE; the first stage of two-stage breast reconstruction) or direct-to-implant (DTI) (Table 1). The exclusion criteria were (1) male sex, (2) nipple-areolar complex reconstruction, (3) code N7150 (implant based-expander addition to a permanent breast implant, which is the second stage of two-stage breast reconstruction), and benign cases (codes N7131 and N7133). Partial mastectomy cases (codes N7136 and N7137) were included; however, the patient populations differed because insurance coverage of breast reconstruction is available only to patients who undergo total mastectomy. Thus, the mastectomy breast reconstruction rates refer only to patients undergoing breast reconstruction after total mastectomy. Data were gathered by medical practice category and procedural code and were categorized as mastectomy or as autologous breast or implant reconstruction. Medical practice statistics were prepared with reference to medical costs requested by healthcare institutions in 2010.

We evaluated the annual changes in the numbers of mastectomies and breast reconstructions (both autologous and implant reconstructions) and patient age distribution from 2015 to 2018. In July 2017, the mastectomy procedural codes were changed from N7130 (radical mastectomy without axillary lymph node dissection [ALND]), N7131 (simple mastectomy), N7133 (partial mastectomy), and N7135 (radical mastectomy) to N7136 (partial mastectomy with ALND), N7137 (partial mastectomy without ALND), N7138 (total mastectomy with ALND), and N7139 (total mastectomy without

ALND).

All data were analyzed using Microsoft Excel (Microsoft Corp., Redmond, WA, USA).

**Table 1. Inclusion criteria for the present study: mastectomy and breast reconstruction procedural codes**

Code	Procedure	Categorization
N7130	Radical mastectomy (including modified radical mastectomy and radical BCS operations; without ALND)	
N7131	Simple mastectomy (benign)	
N7133	Partial mastectomy (benign)	
N7135	Radical mastectomy (including modified radical mastectomy and radical BCS operations)	
N7136	Partial mastectomy (with ALND)	
N7137	Partial mastectomy (without ALND)	
N7138	Total mastectomy (with ALND)	
N7139	Total mastectomy (without ALND)	
N7140	Autologous-LD flap	LD
N7141	Autologous-muscle-sparing LD myocutaneous flap (TDAP)	LD
N7142	Autologous-extended LD myocutaneous flap	LD
N7143	Autologous-pecticled TRAM flap	PTRAM
N7144	Autologous-bipedicled TRAM flap	PTRAM
N7145	Autologous-transverse TRAM free flap	FTRAM
N7146	Autologous-muscle sparing TRAM free flap	FTRAM
N7147	Autologous-DIEP	FTRAM
N7148	Implant based-expander insertion (2 stage breast reconstruction, first stage)	TE
N7149	Implant based-DTI	DTI

BCS, breast-conserving surgery; ALND, axillary lymph node dissection; LD, latissimus dorsi; TDAP, thoracodorsal artery perforator; TRAM, transverse rectus abdominis musculocutaneous; PTRAM, single-pecticled TRAM flap and bipedicled TRAM flap; FTRAM, free TRAM flap, muscle-sparing TRAM flap, and DIEP free flap; DIEP, deep inferior epigastric artery perforator; TE, tissue expander; DTI, direct-to-implant.

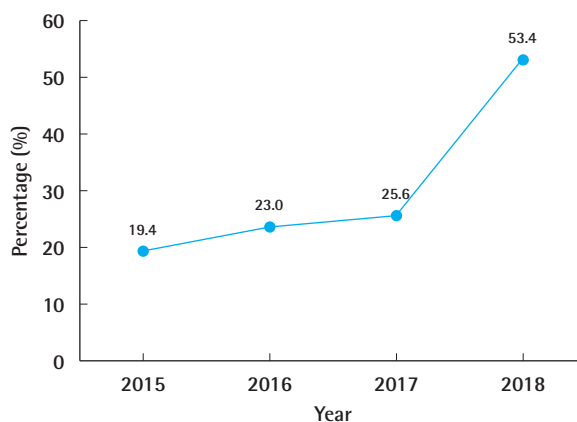
## RESULTS

We examined all data regarding mastectomy and breast reconstruction procedures performed between April 2015 and December 2018. The total number of mastectomy procedures (simple, partial, and total) increased from 21,756 in 2015 to 34,072 in 2018, constituting approximately a 56.6% increase. Simple (benign) and partial mastectomies increased from 10,038 in 2015 to 24,212 in 2018. Total mastectomies decreased from 11,718 in 2015 to 9,860 in 2018 (Fig. 1).

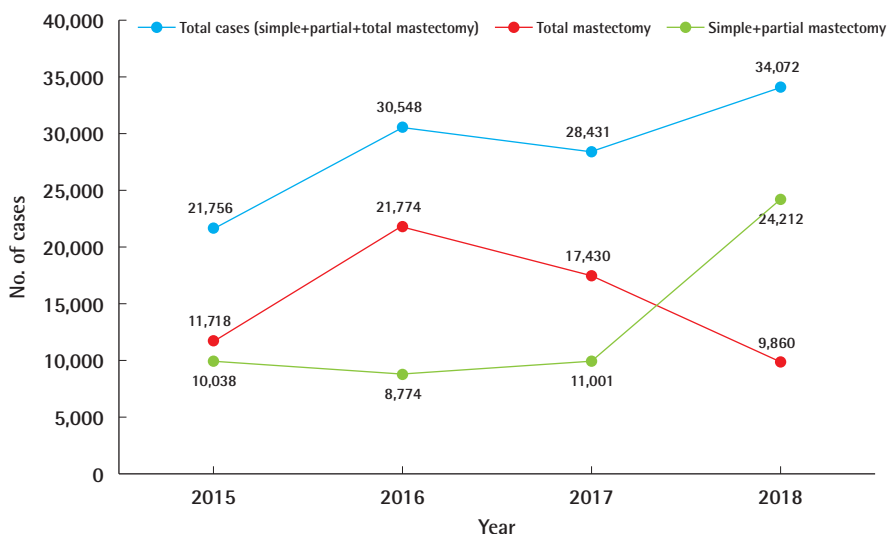
The rate of post-mastectomy breast reconstruction increased from 19.4% in 2015 to 53.4% in 2018 (Fig. 2). In 2015, there were 1,366 cases of implant reconstruction and 905 cases of au-

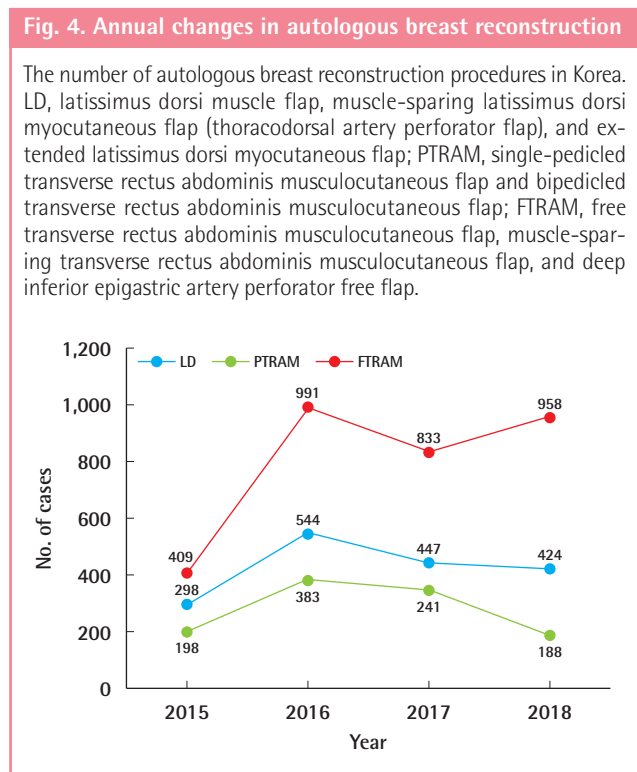
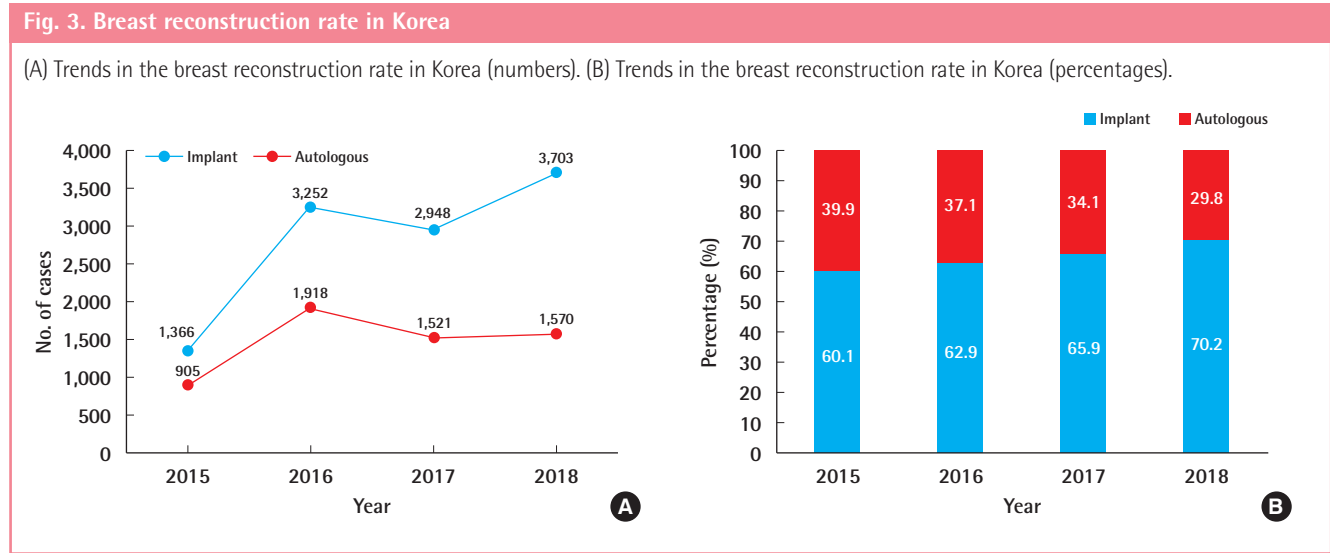
**Fig. 2. Annual changes in breast reconstruction**

The rate of post-mastectomy breast reconstruction in Korea.

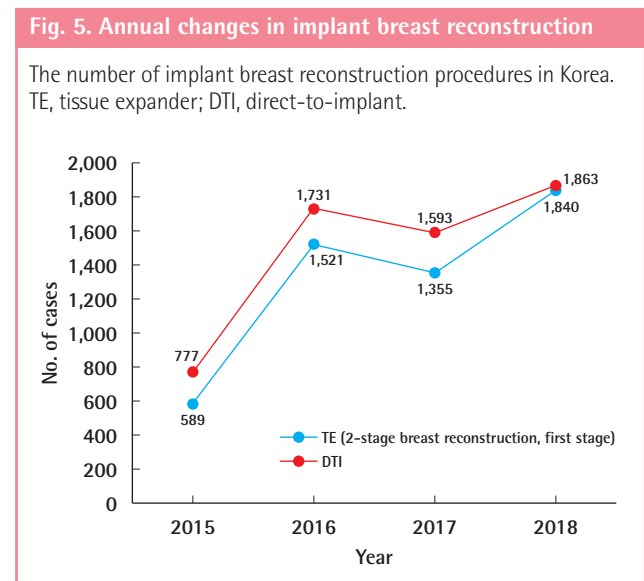


**Fig. 1. Annual changes in mastectomy numbers in Korea**





tologous reconstruction (60.1% and 39.8% of total cases, respectively); in 2018, these rates were 3,703 (70.2%) and 1,570 (29.7%), respectively (Fig. 3). Of the 905 autologous reconstruction cases in 2015, 298 (32.9%) featured placement of an LD flap, 198 (21.9%) involved placement of a PTRAM flap, and 409 (45.2%) involved placement of FTRAM or DIEP flaps. Of the 1,570 such cases in 2018, these figures were 424 (27.0%), 188 (11.9%), and 958 (61.0%), respectively (Fig. 4). FTRAM or DIEP flaps were preferred from 2015 to 2018. Of the 1,366

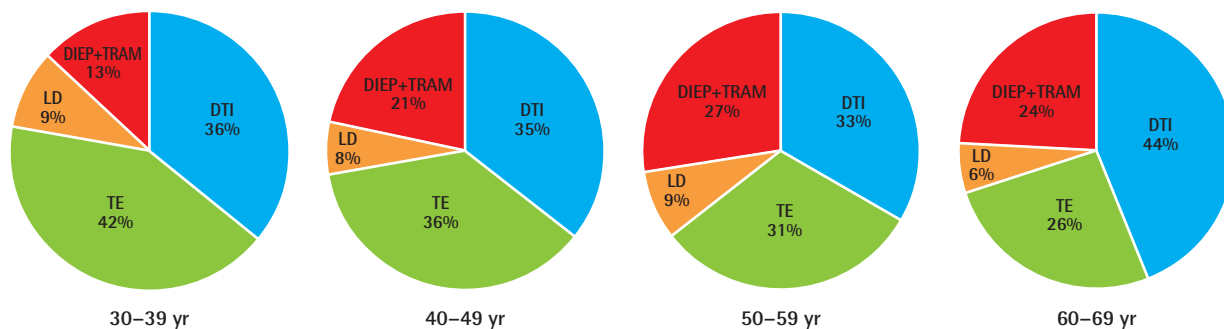


777 (56.9%) were DTI reconstructions, while 589 (43.1%) were TE reconstructions (first stage). In 2018, these figures were 1,863 (50.3%) and 1,840 (49.7%), respectively (Fig. 5). The proportions of DTI and TE breast reconstructions (first stage) were thus similar in 2018.

Between 2015 and 2018, the predominant age group of patients undergoing breast reconstruction was 40–49 years (Table 2), and the age distribution did not vary greatly over time. In 2018, younger patients (30–39 years of age) preferred implant reconstruction (78.9%; autologous reconstructions, 22.1%). In older patients (60–69 years of age), autologous breast reconstruction was somewhat more popular (implant reconstructions, 69.6%; autologous reconstructions, 30.4%) than in younger patients (Fig. 6). Patients under 20 years old and patients over 70 years old were excluded from the results due to

**Fig. 6. Breast reconstruction procedures performed in 2018**

LD, latissimus dorsi muscle flap, muscle-sparing latissimus dorsi myocutaneous flap (thoracodorsal artery perforator flap), and extended latissimus dorsi myocutaneous flap; DIEP+TRAM, single-pedicled transverse rectus abdominis musculocutaneous flap, bipediced transverse rectus abdominis musculocutaneous flap, free transverse rectus abdominis musculocutaneous flap, muscle-sparing transverse rectus abdominis musculocutaneous flap, and deep inferior epigastric artery perforator (DIEP) free flap; TE, tissue expander; DTI, direct-to-implant.



**Table 2. Numbers of breast reconstruction cases by age group from 2015 to 2018**

Year	Age (yr)			
	30-39	40-49	50-59	60-69
2015	335 (15)	1,011 (47)	700 (32)	126 (6)
2016	812 (17)	2,352 (48)	1,386 (29)	291 (6)
2017	690 (17)	2,025 (49)	1,230 (30)	181 (4)
2018	852 (16)	2,414 (47)	1,510 (29)	392 (8)

Values are presented as number (%).

insufficient sample size.

## DISCUSSION

Post-mastectomy breast reconstruction affords psychological, social, emotional, and functional improvements and enhances self-esteem, sexuality, and body image. Patients requiring breast reconstruction face complex decisions regarding reconstruction type and timing. In 2016, 37% of breast cancer patients underwent total mastectomy, while only 23% underwent breast reconstruction [2]. In the early 2000s, when the total mastectomy rate was approximately 50%, fewer than 20% of eligible patients underwent breast reconstruction. In the United States, the federal WHCRA (enacted in 1998) guaranteed coverage of reconstruction fees incurred after mastectomy [8]. It remains unclear whether the WHCRA has increased the rate of breast reconstruction; however, a recent study reported a significant increase [9,10].

In Korea, breast reconstruction after total mastectomy has been covered by the NHIS since April 2015. Autologous and implant breast reconstructions, nipple-areolar complex reconstructions, and additional operations required due to post-re-

construction complications or deformities are also covered [11]. Prior to April 2015, breast reconstruction numbers were low, as such procedures were considered primarily cosmetic.

Our work was rendered possible by our access to the HIRA Big Data Hub. HIRA is the sole nationwide third-party administrator that reviews health insurance claims, thereby assessing the functions of the Korean NHIS. HIRA is an independent agency. Individuals pay premiums to the NHIS and then receive healthcare services with only small copayments. Healthcare providers submit claims to HIRA, which reviews them and sends the results to both the NHIS and the providers. The NHIS then reimburses the providers. The HIRA database retains all claims made by the entire Korean population (50 million people) for a 5-year period [12].

In the United States, relatively accurate data on breast reconstruction are available for all years from 1998 (when the WHCRA took effect) onward; however, in Korea, most earlier breast reconstruction studies relied on retrospective surveys or small clinical samples. The HIRA data collected since April 2015 are highly accurate and reliable.

The Plastic Surgery Statistics Report (2018) published by the American Society of Plastic Surgeons stated that the numbers of breast reconstruction procedures in the United States in 2000, 2017, and 2018 were 78,832, 106,295, and 101,657 respectively, reflecting an increase of 29% from 2000 to 2018 but a decrease of 4% from 2017 to 2018 [13]. In the United States, the approximate post-mastectomy breast reconstruction rate is 40%. A study of general surgeons treating a population-based sample of 1,844 women diagnosed with breast cancer in 2002 found that only 24% of surgeons referred more than 75% of their mastectomy patients to plastic surgeons before surgery [14]. In Korea, the numbers of breast reconstruction procedures in 2015 and

2018 were 2,271 and 5,273, respectively, constituting a 132% increase.

In Korea, the breast reconstruction rate after total mastectomy increased from 19% to 53% from 2015 to 2018. Today, more than half of all Korean total mastectomy patients undergo breast reconstruction, both because reconstruction is now covered by the NHIS and because oncological care patterns are changing. Other factors may also be involved. First, we found that the statistics for total mastectomy patients were inaccurate. In July 2017, the procedural codes for mastectomy changed, but accurate data for all mastectomy patients remained available. Previously, there was a tendency to overestimate the numbers of total mastectomy procedures because the procedural codes for total and partial mastectomy were often confused. Second, the number of patients undergoing total mastectomy is decreasing, while the number undergoing partial mastectomy is increasing. As only breast reconstructions after total mastectomy are included in the HIRA Big Data Hub, the reconstruction rate may be higher if reconstructions after partial mastectomy were included.

Currently, autologous breast reconstruction favors the use of FTRAM and DIEP flaps (61% of all reconstructions); the figure is similar in the United States (Plastic Surgery Statistics Report 2018; American Society of Plastic Surgeons), at about 60%. However, the LD flap was the third most-preferred flap in Korea (12%), followed by the PTRAM flap, whereas the LD flap was the second most-preferred flap in the United States (30%) [13].

In both countries, implant reconstruction is more popular than autologous reconstruction. In Korea in 2018, the implant reconstruction rate had increased to 70%, while that in the United States was 82%. Although implant reconstruction was clearly preferred in both Korea and the United States, the frequency by type differed. In Korea, the percentages of DTI and TE reconstructions in 2015 were 57% and 43%, respectively, but by 2018, the proportion of TE reconstructions had increased to 50%. In the United States, the percentages of DTI and TE reconstructions in 2018 were 16% and 84%, respectively [13]. The preference for implant reconstruction has been analyzed elsewhere. Regulatory surveillance of silicone breast implants by the U.S. Food and Drug Administration has allayed safety concerns [15]. Other reasons for choosing implants are the shorter recovery time, absence of a donor site scar, and overall surgical impact. Patients choosing implants seek restoration of the total body image [16]. The social view of beauty has also changed, and women now prefer non-ptotic implants over more natural-appearing autologous reconstruction. Through the increased utilization of implants in post-mastectomy radiation settings, the use of implants has been shown to be acceptable [17]. Changes in

oncological practice have also expanded implant breast reconstruction. Bilateral mastectomies are now more common than before, as contralateral prophylactic mastectomy is favored. This increases the deformity, the need for breast reconstruction, and consequently the need for implants [18].

In terms of breast reconstruction rates by age, 48% of all patients who underwent breast reconstruction in Korea were women aged 40–49 years; in the United States, the corresponding proportion was 50% [13]. The incidence of breast cancer in women aged 40–49 years is the highest among all age groups. In December 2010, the proportion of premenopausal women with breast cancer was higher than that of postmenopausal women. However, in 2015, postmenopausal breast cancer accounted for 53.5% of all breast cancers. The prevalence of breast cancer in premenopausal women is gradually decreasing, but the prevalence of breast cancer in postmenopausal women is increasing [2]. Thus, the total mastectomy rate was highest in those aged 40–49 years, which seems to have impacted the breast reconstruction statistics. The younger the patient, the less likely she is to prefer autologous breast reconstruction; donor site adiposity may be inadequate, and the long recovery time, donor-site morbidity, and scarring are perceived as major detractions [16].

Women over 60 years old accounted for 26% of all mastectomies in 2018; of these women, only 7% underwent breast reconstruction. The autologous reconstruction rate was higher than that in younger women. The determinants of reconstruction-related decision-making in elderly patients have been studied. Appropriate timing and the quality of information imparted by the surgeon were major modifiable factors that improved access to breast reconstruction [19].

Our work has several limitations. First, we lacked accurate data on post-mastectomy breast reconstruction numbers prior to April 2015, when NHIS coverage expanded. A thorough evaluation of raw data from every Korean hospital is required. Also, since only data from April 2015 onward are available for analysis, our data were not representative of the entire year of 2015. Second, the HIRA Big Data Hub registry does not distinguish between immediate and delayed reconstruction. As delayed reconstruction cannot be linked to the year of the mastectomy, we reported only immediate reconstructions. Third, additional procedures, such as fat grafting or placement of acellular dermal matrix, are not reported here. Future multicenter studies and surveys are required to overcome these limitations.

## CONCLUSIONS

The present study provides an overview of trends regarding breast reconstruction in Korea. We assessed annual changes af-

ter expansion of NHIS coverage in April 2015. An increasing frequency of post-mastectomy breast reconstruction procedures was evident, with a predominant trend toward implant breast reconstruction. Analysis of breast reconstruction statistics using the HIRA Big Data Hub is helpful in predicting breast reconstruction trends and provides useful information to patients. Our results indicate that NHIS coverage of breast reconstruction has led to annual increases in the breast reconstruction rate.

## NOTE

### Conflict of interest

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

### Ethical approval

This study was approved by the Institutional Review Board of Soonchunhyang University Hospital, Gumi (IRB No. SCHUH 2019-19) and adhered to all relevant tenets of the Declaration of Helsinki. Written informed consent was obtained from all patients.

### Author contribution

Conceptualization: Song WJ, Kang SG, Kim EK, Song SY, Lee JS, Lee JH, Jin US. Data curation: Song WJ. Formal analysis: Song WJ. Funding acquisition: Kang SG. Methodology: Song WJ, Kim EK, Song SY, Lee JS, Lee JH, Jin US. Project administration: Kang SG. Visualization: Song WJ. Writing - original draft: Song WJ. Writing - review & editing: Song WJ.

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