Original Article

Changing trends in the management of ductal carcinoma in situ in Republic of Korea: a comprehensive analysis using Health Insurance Review and Assessment data [2009–2020]

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Background: Increasing rates of diagnosis of ductal carcinoma in situ (DCIS), given the widespread use of mammography, is a global trend. Various attempts have been made in the selection of surgical methods and application of radiation therapy (RT), and the prevalence of infectious diseases has also affected these attempts. This study aimed to investigate evolving treatment patterns and trends in the management of DCIS in South Korea.

Methods: We conducted a comprehensive search of the Korean Health Insurance Review and Assessment Service-National Patient Sample (HIRA-NPS) database and selected patients who underwent breast surgery following a DCIS diagnosis between 2009 and 2020. Based on this sample, the analyses were weighted according to the Korean population. We examined annual variations in mastectomy types, reconstructive procedures, and RT utilization from a multidisciplinary perspective.

Results: In our weighted sample, 43,780 patients with DCIS underwent surgery, with a consistent annual increase of 10%. The proportion of lumpectomy procedures increased from 56.7% to 65.4%, showing a greater growth rate than that of total mastectomies (TMs). Following the availability of reconstruction data in 2015, shifts have emerged toward a preference for implant-based autologous tissue reconstruction. As we transitioned to the latter part of our study, the trend was marked by the increasing adoption of hypofractionated RT and omission of RT. Of the patients who underwent lumpectomy in 2020, 25.6% adopted hypofractionated RT and 53.8% omitted RT. This transformation was particularly evident among older patients, individuals treated in metropolitan areas, and those treated in small-sized healthcare facilities.

Conclusions: Our study sheds light on the changing landscape of DCIS treatment in South Korea incorporating perspectives from surgeons, plastic surgeons, and radiation oncologists. We observed an increase in the rates of lumpectomy and implant-based reconstruction. Adoption of hypofractionated RT and omission of RT showed increasing trends.

Keywords: Ductal carcinoma in situ (DCIS); Republic of Korea; mastectomy; radiation therapy (RT); radiation dose hypofractionation

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Introduction

Ductal carcinoma in situ (DCIS) is a neoplastic process confined to the ductal system of the breast that lacks histological evidence of invasion. These cells neither disrupt the basement membrane nor are involved in the surrounding breast stroma. Prior to the advent of mammography, pure DCIS was rarely diagnosed. However, owing to the widespread use of mammography, the diagnosis of DCIS has progressively increased over time, now comprising approximately 20–25% of screening-detected breast cancer cases in the United States (1). In Korea, the National Cancer Screening Program plays a crucial role in breast cancer screenings, advocating mammograms every 2 years for women aged 40 or older. The breast cancer screening rate exhibited a notable increase from 33% to 72% between 2004 and 2012 (2). The Korean Breast Cancer Society reported that DCIS accounted for 17.9% of all newly diagnosed breast lesions in 2017 (3), indicating a notable increase from 6.1% in 2000 and underscoring the impact of the national mammographic screening strategy and advancements in diagnostic methods.

The optimal treatment for DCIS remains controversial because there is no consensus regarding the risk of progression to invasive breast cancer or the impact of various therapeutic modalities on survival outcomes (4). The standard of care for DCIS is breast-conserving surgery (BCS) followed by whole-breast radiation therapy (RT), which reduces the risk of local recurrence by approximately 50% compared with BCS alone (5). Despite the effectiveness of BCS with RT, there is an ongoing debate regarding the necessity of adjuvant RT for all DCIS cases (6). This is particularly relevant in the context of the coronavirus disease 2019 (COVID-19) pandemic, which has given rise to unique challenges in the delivery of healthcare services, including RT. The pandemic has prompted a re-evaluation of treatment approaches, with an emphasis on minimizing hospital visits and treatment duration while ensuring optimal patient outcomes (7). In recent years, there has been growing interest in hypofractionated whole-breast irradiation (HF-WBI) as an alternative to conventional fractionation WBI (CF-WBI) in the management of DCIS. HF-WBI delivers high doses of radiation per fraction over a few treatment sessions, potentially offering increased convenience and reduced treatment burden for patients. This approach has shown promising results in invasive breast cancer (8,9), leading to investigations into its applicability and efficacy in DCIS treatment.

In light of these considerations, this study aims to analyze the adoption of hypofractionated RT for DCIS in the Korean population. By examining treatment patterns, we sought to provide valuable insights into the evolving landscape of DCIS management, particularly in the context of changing treatment paradigms influenced by the global pandemic and advancements in surgery and RT techniques. We present this article in accordance with the STROBE reporting checklist (available at https://gs.amegroups.com/article/view/10.21037/gs-23-433/rc).

Highlight box

Key findings
- We observed a significant increase in ductal carcinoma in situ (DCIS) breast surgeries, particularly breast-conserving surgery.
- Utilization of implant-based reconstruction and hypofractionated radiation therapy (RT) showed increasing trends.

What is known and what is new?
- The rise in DCIS diagnoses due to mammographic screening has been reported.
- This study adds insights into the rise of conservative surgical approaches, increased implant-based reconstructions, and preference for hypofractionated RT.

What is the implication, and what should change now?
- The evolving treatment landscape necessitates updated guidelines and extensive targeted research to optimize DCIS management.
- Monitoring surgical changes and discussing RT omission and adoption of hypofractionated RT are imperative for further advancements in DCIS management.

Methods

Data source

South Korea has a universal health coverage system—the National Health Insurance Service (NHIS)—that covers approximately 98% of the country's population. The Health

Insurance Review and Assessment Service (HIRA) reviews and evaluates the appropriateness of medical expenses claimed by medical institutions. The HIRA provides a Big Data Hub that allows researchers to analyze claims data and conduct population-based studies (10). The HIRA-National Patient Sample (HIRA-NPS) includes a stratified random sample of 3% of the total patients during each annual period from 2009 to 2018 and 5% during 2019 and 2020. The HIRA provides data on four types of patient samples: national, inpatient, pediatric, and aged population samples. We also collected the 1-year history of medical service use, demographics, and clinical details of the anonymized patients. This study was conducted in accordance with the Declaration of Helsinki (revised in 2013). This study was approved by the Institutional Review Board of Pusan National University Yangsan Hospital (IRB No. 05-2022-128), and the requirement for individual consent for this retrospective analysis was waived.

Patient selection

The diagnostic code for DCIS was D05. Individuals diagnosed with invasive breast carcinoma (C50), whether before or after the diagnosis of DCIS, were excluded. The codes for breast surgery were as follows: N7131, N7132, N7138, and N7139 for total mastectomy (TM); N7133, N7134, N7136, and N7137 for BCS; and N7130 and N7135 for radical surgeries that include TM and BCS. The codes for RT were HD05 and HD06 for the three-dimensional conformal plan and HZ271 for intensity-modulated RT (IMRT). Patients with RT codes in the same year of surgery were assigned to the BCS group. Patients who did not undergo RT within the same year were assigned to the TM group. Subsequently, axillary and breast reconstruction surgeries were performed. The surgical and corresponding codes are listed in *Table 1*. For the analysis of radiation fractionation, the data of patients who received their first radiation treatment between February and November, annually, were collected separately.

Statistical analysis

The baseline characteristics of the patients who received or did not receive hypofractionated RT were compared using the chi-square test for categorical variables. The parameters considered for evaluation included the year of diagnosis (2009–2014 and 2015–2020), patient age (<70 and ≥70 years), and axillary evaluation (performed or not performed). The hospitals of surgery were classified into the following regions: region I (Seoul *vs.* non-Seoul), region II [capital area (Seoul + Gyeonggi) *vs.* non-capital area], and region III [metropolitan area (capital area + metropolitan city) *vs.* non-metropolitan area]. The size of the hospital of surgery was determined according to the number of beds (<800 *vs.* ≥800). Based on the number of days for which HD05, HD06, or HZ271 was prescribed, patients were grouped into no-RT, hypofractionated RT (15–20 fractions), and conventional fractionation RT (21 fractions or more). The regions and sizes of the RT hospitals were also determined.

Results

Between 2009 and 2020, the HIRA-NPS database included 304,100,188 claims (1,481,921 patients). Of these, 7,623 patients had the D05 diagnostic code. Among them, 1,248 (16.4%) patients underwent breast surgery and fulfilled the inclusion criteria (*Figure 1*). The sample was weighted to represent the Korean population, resulting in a sample size of 43,780 cases. The average number of breast surgeries for DCIS per year was 4,092, with a 10% annual increase from 2,211 in 2009 to 6,500 in 2020 (*Figure 2*). The number of BCS cases increased from 1,254 (56.7%) in 2009 to 4,400 (72.1%) in 2019 but decreased to 4,250 (65.4%) in 2020. The number of TM cases increased from 957 (43.3%) in 2009 to 2,250 (34.6%) in 2020, with a marked increase in both numbers and rates from 2014 to 2016. Since April 1, 2015, breast reconstruction surgery has been covered by the NHIS in South Korea, allowing the HIRA to collect data on the number of breast reconstruction cases. Between 2015 and 2020, 6,580 patients underwent reconstruction for DCIS: 5,123 (77.9%) underwent implant reconstruction and 1,374 (20.9%) underwent autologous reconstruction. In 2015, 462 (63.6%) of reconstructions were implant and 264 (36.4%) were autologous, while in 2020, 1,600 (88.9%) were implant and 200 (11.1%) were autologous (*Figure 3*). The annual rate of increase in implant reconstructions was 28%. *Table 2* presents the annual trends in patient age, type of breast surgery, axillary surgery, reconstruction, adjuvant radiation, hospital region, and hospital size.

The characteristics of the separate cohort for hypofractionated RT analysis are presented in *Table 3*. *Figure 4* illustrates the trends in RT omission and the use of conventional fractionation RT and hypofractionated RT. Conventional fractionation RT was used in 429 (37.1%) patients in 2009, increasing to 1,287 (62.9%) in 2014, but decreasing to 700 (17.9%) by 2020 after 2014. In the

Table 1 Surgery codes

Code	Description	Category
N7130	Radical mastectomy, including modified radical mastectomy and radical breast-conserving operations	BCS (with HD05, HD06, HZ271)
		TM (without HD05, HD06, HZ271)
N7131	Simple mastectomy	TM
N7132	Subcutaneous mastectomy	TM
N7133	Partial mastectomy	BCS
N7134	Excision of accessory breast	BCS
N7135	Radical mastectomy, including modified radical mastectomy and radical breast-conserving operations	BCS (with HD05, HD06, HZ271)
		TM (without HD05, HD06, HZ271)
N7136	Partial mastectomy with axillary lymphadenectomy	BCS
N7137	Partial mastectomy	BCS
N7138	Radical mastectomy including axillary lymph nodes	TM
N7139	Radical mastectomy	TM
N7140	Reconstruction of breast using myocutaneous flap of latissimus dorsi muscle	Breast reconstruction—autologous
N7141	Reconstruction of breast using myocutaneous flap of latissimus dorsi muscle	Breast reconstruction—autologous
N7142	Reconstruction of breast using myocutaneous flap of latissimus dorsi muscle	Breast reconstruction—autologous
N7143	Reconstruction of breast using pedicled transverse rectus abdominis myocutaneous flap	Breast reconstruction—autologous
N7144	Breast reconstruction, bilateral, with bilateral pedicle transverse rectus abdominis myocutaneous flaps	Breast reconstruction—autologous
N7145	Reconstruction of breast using free transverse rectus abdominis myocutaneous flap	Breast reconstruction—autologous
N7146	Reconstruction of breast using free transverse rectus abdominis myocutaneous flap	Breast reconstruction—autologous
N7147	Breast reconstruction with deep inferior epigastric perforator skin flap	Breast reconstruction—autologous
N7148	Reconstruction of breast with expander or prosthesis	Breast reconstruction—implant based
N7149	Immediate insertion of breast prosthesis	Breast reconstruction—implant based
N7150	Insertion of prosthesis for breast	Breast reconstruction—implant based
N7151	Periprosthetic capsulectomy of breast	Breast reconstruction—implant based
N7152	Nipple reconstruction	Breast reconstruction—nipple-areolar reconstruction
N7153	Reconstruction of areola	Breast reconstruction—nipple-areolar reconstruction
P2121	Excision of axillary lymph node	Excision
P2122	Complete axillary lymphadenectomy	Axillary dissection
P2123	Excision of sentinel lymph node	Sentinel lymph node biopsy
P2124	Radionuclide scan of sentinel lymph node of breast	Sentinel lymph node biopsy

BCS, breast-conserving surgery; TM, total mastectomy.

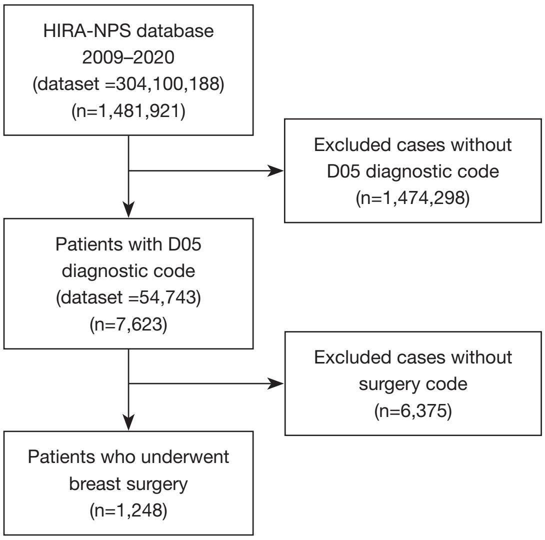

Figure 1 Process for inclusion and exclusion of patients in the study. HIRA-NPS, Health Insurance Review and Assessment Service-National Patient Sample.

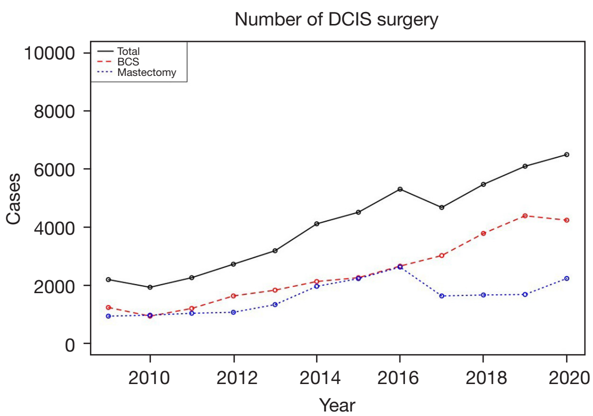

Figure 2 Trends of breast surgery types in patients with DCIS by year. DCIS, ductal carcinoma in situ; BCS, breast-conserving surgery.

later treatment period, the proportion of patients who received hypofractionated RT or omitted RT increased. Hypofractionated RT was used in 132 (6.5%) patients in 2014 and in 1,000 (25.6%) patients in 2020. The number of patients who did not receive RT was 594 (29.0%) in 2014 and 2,100 (53.8%) in 2020. The rate of RT omission was higher in the later treatment period [2015–2020], among patients over the age of 70 years, in metropolitan areas, and in small-volume hospitals. The rate of hypofractionated RT steadily increased during the later study period. In 2009,

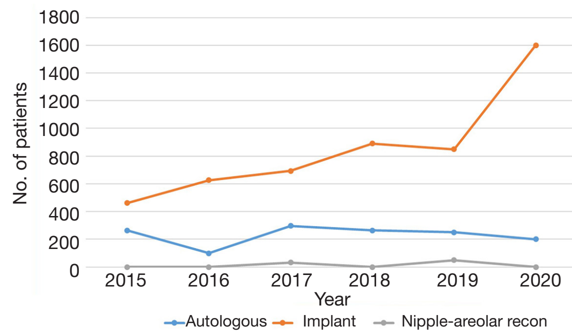

Figure 3 Annual trends in breast reconstruction types for patients with DCIS. DCIS, ductal carcinoma in situ.

the rates of hypofractionated and conventional fractionation RT were 5.7% and 37.1%, respectively. In 2020, these rates were 25.6% and 17.9%, respectively. The rate of hypofractionated RT was significantly higher in the later period, after axillary surgery, among older patients, among those who received radiation in the capital area, and among those who received IMRT in large hospitals. The odds ratios are presented in *Table 4*.

Discussion

Data from the HIRA-NPS database collected between 2009 and 2020 revealed an increasing trend in breast surgeries for DCIS, with the majority being BCS. After 2014, the uptake of implant-based breast reconstruction procedures significantly increased. The use of conventional fractionation RT decreased over time, whereas the use of hypofractionated RT and RT omission showed a steady increase, particularly in older patients.

The treatment pattern shift observed in South Korea for DCIS, with a gradual increase in lumpectomy with radiation (28.4–39.3%) and a decrease in mastectomy rates (43.3–27.9%), mirrors the trend in the United States. In the US, the adoption of lumpectomy with RT increased by almost 100% (24.2–46.8%), whereas that of unilateral mastectomy decreased by 60% (44.9–19.3%) (11). Currently, in both South Korea and the US, the most preferred treatment approach for DCIS is lumpectomy followed by WBI. These treatment trends are backed by the results of a representative meta-analysis conducted by the Early Breast Cancer Trialists' Collaborative Group (EBCTCG) in 2010, which included 3,700 locally excised DCIS cases from four randomized control trials (5). Adjuvant RT reduced the rate of ipsilateral breast events by approximately half

Table 2 Annual trends in patient age, type of breast surgery, axillary surgery, reconstruction, adjuvant radiation, hospital region, and hospital size

Variables	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Age (years)												
20–29	33 (1.5)	66 (3.4)	66 (2.9)	0 (0.0)	99 (3.1)	0 (0.0)	99 (2.2)	0 (0.0)	99 (2.1)	0 (0.0)	50 (0.8)	250 (3.9)
30–39	363 (16.4)	165 (8.5)	429 (18.8)	462 (16.9)	363 (11.3)	594 (14.4)	594 (13.1)	594 (11.2)	660 (14.1)	462 (8.4)	650 (10.7)	600 (9.3)
40–49	1,056 (47.8)	891 (45.8)	627 (27.5)	1,089 (39.8)	1,518 (47.4)	1,518 (36.8)	1,782 (39.4)	2,178 (41.0)	1,551 (33.1)	1,980 (36.1)	2,050 (33.6)	2,700 (41.9)
50–59	528 (23.9)	495 (25.4)	660 (29.0)	759 (27.7)	825 (25.8)	1,221 (29.6)	1,221 (27.0)	1,287 (24.2)	1,551 (33.1)	1,584 (28.9)	1,650 (27.0)	1,800 (27.9)
60–69	198 (9.0)	231 (11.9)	396 (17.4)	264 (9.6)	132 (4.1)	528 (12.8)	627 (13.9)	891 (16.8)	594 (12.7)	1,056 (19.3)	1,500 (24.6)	900 (14.0)
≥70	33 (1.5)	99 (5.1)	99 (4.3)	165 (6.0)	264 (8.2)	264 (6.4)	198 (4.4)	363 (6.8)	231 (4.9)	396 (7.2)	200 (3.3)	200 (3.1)
Combined age (years)												
<70	2,178 (98.5)	1,848 (94.9)	2,178 (95.7)	2,574 (94.0)	2,937 (91.8)	3,861 (93.6)	4,323 (95.6)	4,950 (93.2)	4,455 (95.1)	5,082 (92.8)	5,900 (96.7)	6,250 (96.9)
≥70	33 (1.5)	99 (5.1)	99 (4.3)	165 (6.0)	264 (8.2)	264 (6.4)	198 (4.4)	363 (6.8)	231 (4.9)	396 (7.2)	200 (3.3)	200 (3.1)
Surgery type												
BCS	1,254 (56.7)	957 (49.2)	1,221 (53.6)	1,650 (60.2)	1,848 (57.7)	2,145 (52.0)	2,277 (50.4)	2,673 (50.3)	3,036 (64.8)	3,795 (69.3)	4,400 (72.1)	4,250 (65.4)
TM	957 (43.3)	990 (50.8)	1,056 (46.4)	1,089 (39.8)	1,353 (42.3)	1,980 (48.0)	2,244 (49.6)	2,640 (49.7)	1,650 (35.2)	1,683 (30.7)	1,700 (27.9)	2,250 (34.6)
Axillary surgery												
ALND	0 (0.0)	33 (6.2)	0 (0.0)	0 (0.0)	33 (2.9)	33 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Excision	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	33 (2.6)	0 (0.0)	0 (0.0)	33 (0.9)	0 (0.0)	0 (0.0)
SNB	561 (100.0)	495 (93.8)	627 (100.0)	1,023 (100.0)	1,122 (97.1)	1,287 (97.5)	1,221 (97.4)	2,343 (100.0)	2,772 (100.0)	3,498 (99.1)	3,950 (100.0)	4,200 (100.0)
Reconstruction surgery												
Autologous	–	–	–	–	–	–	264 (36.4)	99 (13.6)	297 (29.0)	264 (22.9)	250 (21.7)	200 (11.1)
Implant	–	–	–	–	–	–	462 (63.6)	627 (86.4)	693 (67.7)	891 (77.1)	850 (73.9)	1,600 (88.9)
Nipple-areolar reconstruction	–	–	–	–	–	–	0 (0.0)	0 (0.0)	33 (3.2)	0 (0.0)	50 (4.3)	0 (0.0)
RT												
No	1,551 (70.1)	1,287 (66.1)	1,584 (69.6)	1,353 (49.4)	1,914 (59.8)	2,508 (60.8)	3,003 (66.4)	3,399 (64.0)	2,937 (62.7)	3,894 (71.1)	3,700 (60.7)	4,300 (66.2)
Yes	660 (29.9)	660 (33.9)	693 (30.4)	1,386 (50.6)	1,287 (40.2)	1,617 (39.2)	1,518 (33.6)	1,914 (36.0)	1,749 (37.3)	1,584 (28.9)	2,400 (39.3)	2,200 (33.8)
Surgery-RT												
BCS alone	627 (28.4)	330 (16.9)	561 (24.6)	330 (12.0)	561 (17.5)	594 (14.4)	825 (18.2)	792 (14.9)	1,320 (28.2)	2,244 (41.0)	2,000 (32.8)	2,100 (32.3)
BCS + RT	627 (28.4)	627 (32.2)	660 (29.0)	1,320 (48.2)	1,287 (40.2)	1,551 (37.6)	1,452 (32.1)	1,881 (35.4)	1,716 (36.6)	1,551 (28.3)	2,400 (39.3)	2,150 (33.1)
TM alone	924 (41.8)	957 (49.2)	1,023 (44.9)	1,023 (37.3)	1,353 (42.3)	1,914 (46.4)	2,178 (48.2)	2,607 (49.1)	1,617 (34.5)	1,650 (30.1)	1,700 (27.9)	2,200 (33.8)
TM + RT	33 (1.5)	33 (1.7)	33 (1.4)	66 (2.4)	0 (0.0)	66 (1.6)	66 (1.5)	33 (0.6)	33 (0.7)	33 (0.6)	0 (0.0)	50 (0.8)

Table 2 (*continued*)

Table 2 (*continued*)

Variables	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Region of surgery I												
Non-Seoul	1,155 (52.2)	990 (50.8)	990 (43.5)	1,518 (55.4)	1,782 (55.7)	2,211 (53.6)	2,310 (51.1)	2,937 (55.3)	2,640 (56.3)	2,937 (53.6)	3,050 (50.0)	3,350 (51.5)
Seoul	1,056 (47.8)	957 (49.2)	1,287 (56.5)	1,221 (44.6)	1,419 (44.3)	1,914 (46.4)	2,211 (48.9)	2,376 (44.7)	2,046 (43.7)	2,541 (46.4)	3,050 (50.0)	3,150 (48.5)
Region of surgery II												
Non-capital	858 (38.8)	495 (25.4)	528 (23.2)	792 (28.9)	957 (29.9)	1,056 (25.6)	1,320 (29.2)	1,683 (31.7)	1,848 (39.4)	1,584 (28.9)	1,950 (32.0)	2,000 (30.8)
Capital area	1,353 (61.2)	1,452 (74.6)	1,749 (76.8)	1,947 (71.1)	2,244 (70.1)	3,069 (74.4)	3,201 (70.8)	3,630 (68.3)	2,838 (60.6)	3,894 (71.1)	4,150 (68.0)	4,500 (69.2)
Region of surgery III												
Non-metropolitan	297 (13.4)	231 (11.9)	231 (10.1)	198 (7.2)	231 (7.2)	429 (10.4)	396 (8.8)	759 (14.3)	759 (16.2)	693 (12.7)	650 (10.7)	500 (7.7)
Metropolitan	1,914 (86.6)	1,716 (88.1)	2,046 (89.9)	2,541 (92.8)	2,970 (92.8)	3,696 (89.6)	4,125 (91.2)	4,554 (85.7)	3,927 (83.8)	4,785 (87.3)	5,450 (89.3)	6,000 (92.3)
Size of hospital of surgery												
<800 beds	891 (40.3)	627 (32.2)	990 (43.5)	924 (33.7)	1,551 (48.5)	1,683 (40.8)	1,353 (29.9)	1,617 (30.4)	1,749 (37.3)	1,848 (33.7)	2,350 (38.5)	2,350 (36.2)
≥800 beds	1,320 (59.7)	1,320 (67.8)	1,287 (56.5)	1,815 (66.3)	1,650 (51.5)	2,442 (59.2)	3,168 (70.1)	3,696 (69.6)	2,937 (62.7)	3,630 (66.3)	3,750 (61.5)	4,150 (63.8)

Data are presented as number (%), unless otherwise indicated. BCS, breast-conserving surgery; TM, total mastectomy; ALND, axillary lymph node dissection; SNB, sentinel node biopsy; RT, radiation therapy.

compared to non-adjuvant RT (rate ratio, 0.46), including recurrent DCIS or invasive cancer, with an absolute 10-year risk reduction of 15.2%. Remarkably, RT was effective regardless of patient age, surgical extent, tamoxifen use, margins, or clinical presentation. Even in women with small, low-grade tumors and negative margins, a notable absolute reduction in the risk of ipsilateral breast events was observed. Long-term results from these trials reaffirmed the sustained effect of RT in reducing intramammary recurrence by half and maintaining an absolute risk reduction of 10–12%, although none of the studies showed a significant effect on breast cancer mortality (12-14). A recent study found that BCS + adjuvant RT had a low 6% overall recurrence rate at 85 months follow-up, with margin status, multifocality, hormone receptor status, and Her-2/Basal-like subtype identified as risk factors for local recurrence (15). Mastectomy, which is predominantly recommended when complete surgical removal through BCS is not feasible, has shown excellent outcomes. Studies on mastectomy have reported a high locoregional control rate of 96–100% and a low cancer-specific mortality rate of less than 4% (16,17). Given that the vast majority of the breast glandular tissue is removed during mastectomy, the incidence of invasive breast cancer recurrence is extremely rare. The reported ipsilateral breast recurrence rates are 0.8–1.9% after mastectomy, 4.1–8.8% after BCS + RT, and 7.2–15.4% after BCS alone (17,18). The move from mastectomy to lumpectomy with radiation is influenced by the increased diagnosis of small-sized DCIS, propelled by expanded screening programs (2). Increased patient preference for breast conservation and robust clinical evidence are also contributing to this shift.

The increase in TM rates from 2014 to 2016 can be attributed to the implementation of coverage by the NHIS in April 2015 (19). NHIS coverage significantly reduced the high cost of breast reconstruction, resulting in a notable decrease in the expenses faced by patients for autologous tissue- and prosthesis-based breast reconstruction, nipple-areolar complex reconstruction, and additional operations due to complications or deformities after reconstruction. According to a study, after NHIS coverage expansion, surgery-related costs, including anesthesia, inpatient care, and medication, decreased by half. Some patients strategically scheduled cancer operations post-April 2015 to lower expenses. A rise in post-2015 delayed breast reconstruction among breast cancer survivors with deformities may be attributed to reduced costs (20). Data on the type of breast reconstruction have become available since

Table 3 Annual trends of the characteristics of the separate cohort that utilized hypofractionation

Variables	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Age (years)												
20–29	33 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	66 (3.8)	0 (0.0)	33 (1.7)	0 (0.0)	99 (3.6)	0 (0.0)	50 (1.2)	100 (2.6)
30–39	198 (17.1)	66 (8.3)	198 (17.6)	231 (15.9)	165 (9.4)	330 (16.1)	231 (11.7)	165 (6.9)	363 (13.3)	396 (10.8)	400 (9.5)	250 (6.5)
40–49	627 (54.3)	396 (50.0)	264 (23.5)	693 (47.7)	924 (52.8)	792 (38.7)	957 (48.3)	990 (41.7)	825 (30.1)	1,287 (35.1)	1,550 (36.9)	1,600 (41.6)
50–59	165 (14.3)	264 (33.3)	429 (38.2)	297 (20.5)	396 (22.6)	561 (27.4)	396 (20.0)	693 (29.2)	957 (34.9)	1,254 (34.2)	1,050 (25.0)	1,150 (29.9)
60–69	132 (11.4)	66 (8.3)	165 (14.7)	132 (9.1)	33 (1.9)	231 (11.3)	264 (13.3)	396 (16.7)	297 (10.8)	429 (11.7)	1,000 (23.8)	550 (14.3)
≥70	0 (0.0)	0 (0.0)	66 (5.9)	99 (6.8)	165 (9.4)	132 (6.5)	99 (5.0)	132 (5.6)	198 (7.2)	297 (8.1)	150 (3.6)	200 (5.2)
Combined age (years)												
<70	1,155 (100.0)	792 (100.0)	1,056 (94.1)	1,353 (93.2)	1,584 (90.6)	1,914 (93.5)	1,881 (95.0)	2,244 (94.4)	2,541 (92.8)	3,366 (91.9)	4,050 (96.4)	3,650 (94.8)
≥70	0 (0.0)	0 (0.0)	66 (5.9)	99 (6.8)	165 (9.4)	132 (6.5)	99 (5.0)	132 (5.6)	198 (7.2)	297 (8.1)	150 (3.6)	200 (5.2)
Axillary surgery												
ALND	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	33 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Excision	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	33 (4.8)	0 (0.0)	0 (0.0)	33 (1.7)	0 (0.0)	0 (0.0)
SNB	330 (100.0)	165 (100.0)	264 (100.0)	627 (100.0)	627 (95.0)	594 (100.0)	660 (95.2)	825 (100.0)	1,254 (100.0)	1,881 (98.3)	2,200 (100.0)	2,250 (100.0)
RT												
No	627 (54.3)	330 (41.7)	561 (50.0)	330 (22.7)	561 (32.1)	594 (29.0)	825 (41.7)	792 (33.3)	1,320 (48.2)	2,244 (61.3)	2,000 (47.6)	2,100 (53.8)
Yes	528 (45.7)	462 (58.3)	561 (50.0)	1,122 (77.3)	1,188 (67.9)	1,452 (71.0)	1,155 (58.3)	1,584 (66.7)	1,419 (51.8)	1,419 (38.7)	2,200 (52.4)	1,800 (46.2)
Region of surgery I												
Non-Seoul	264 (50.0)	264 (57.1)	330 (58.8)	693 (61.8)	627 (52.8)	726 (50.0)	759 (65.7)	1,089 (68.8)	990 (69.8)	957 (67.4)	1,200 (54.5)	1,000 (55.6)
Seoul	264 (50.0)	198 (42.9)	231 (41.2)	429 (38.2)	561 (47.2)	726 (50.0)	396 (34.3)	495 (31.2)	429 (30.2)	462 (32.6)	1,000 (45.5)	800 (44.4)
Region of surgery II												
Non-capital	363 (31.4)	132 (16.7)	231 (20.6)	462 (31.8)	561 (32.1)	594 (29.0)	726 (36.7)	792 (33.3)	1,089 (39.8)	1,221 (33.3)	1,450 (34.5)	1,100 (28.2)
Capital area	792 (68.6)	660 (83.3)	891 (79.4)	990 (68.2)	1,188 (67.9)	1,452 (71.0)	1,254 (63.3)	1,584 (66.7)	1,650 (60.2)	2,442 (66.7)	2,750 (65.5)	2,800 (71.8)
Region of surgery III												
Non-metropolitan	198 (17.1)	33 (4.2)	66 (5.9)	99 (6.8)	165 (9.4)	198 (9.7)	264 (13.3)	231 (9.7)	363 (13.3)	561 (15.3)	450 (10.7)	300 (7.7)
Metropolitan	957 (82.9)	759 (95.8)	1,056 (94.1)	1,353 (93.2)	1,584 (90.6)	1,848 (90.3)	1,716 (86.7)	2,145 (90.3)	2,376 (86.7)	3,102 (84.7)	3,750 (89.3)	3,600 (92.3)
Size of hospital of surgery												
<800 beds	396 (34.3)	231 (29.2)	462 (41.2)	528 (36.4)	891 (50.9)	825 (40.3)	660 (33.3)	693 (29.2)	1,254 (45.8)	1,320 (36.0)	1,750 (41.7)	1,500 (38.5)
≥800 beds	759 (65.7)	561 (70.8)	660 (58.8)	924 (63.6)	858 (49.1)	1,221 (59.7)	1,320 (66.7)	1,683 (70.8)	1,485 (54.2)	2,343 (64.0)	2,450 (58.3)	2,400 (61.5)

Table 3 (*continued*)

Table 3 *(continued)*

Variables	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
RT technique												
3D	528 (100.0)	462 (100.0)	561 (100.0)	1,122 (100.0)	1,188 (100.0)	1,452 (100.0)	1,155 (100.0)	1,518 (95.8)	1,287 (90.7)	825 (58.1)	1,700 (77.3)	950 (52.8)
IMRT	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	66 (4.2)	132 (9.3)	594 (41.9)	500 (22.7)	850 (47.2)
RT fractionation												
No RT	627 (54.3)	330 (41.7)	561 (50.0)	330 (22.7)	561 (32.1)	594 (29.0)	825 (41.7)	792 (33.3)	1,320 (48.2)	2,244 (61.3)	2,000 (47.6)	2,100 (53.8)
1–14	33 (2.9)	0 (0.0)	0 (0.0)	66 (4.5)	0 (0.0)	33 (1.6)	66 (3.3)	33 (1.4)	132 (4.8)	66 (1.8)	50 (1.2)	100 (2.6)
15–20	66 (5.7)	33 (4.2)	0 (0.0)	66 (4.5)	198 (11.3)	132 (6.5)	33 (1.7)	330 (13.9)	264 (9.6)	792 (21.6)	1,000 (23.8)	1,000 (25.6)
≥21	429 (37.1)	429 (54.2)	561 (50.0)	990 (68.2)	990 (56.6)	1,287 (62.9)	1,056 (53.3)	1,221 (51.4)	1,023 (37.3)	561 (15.3)	1,150 (27.4)	700 (17.9)

Data are presented as number (%), unless otherwise indicated. ALND, axillary lymph node dissection; SNB, sentinel node biopsy; RT, radiation therapy; 3D, three-dimensional; IMRT, intensity-modulated RT.

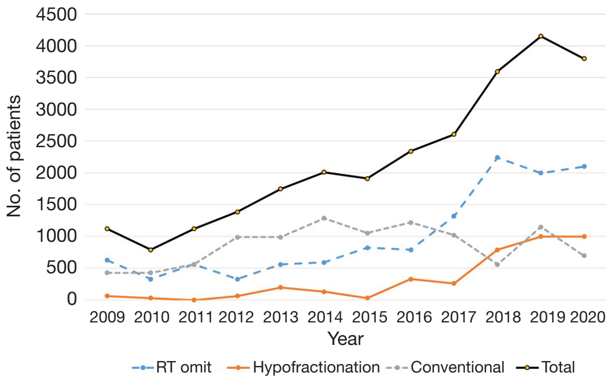

Figure 4 Trends of use in adjuvant RT including omission, conventional fractionation RT, or hypofractionation RT. RT, radiation therapy.

the implementation of NHIS coverage. In 2015, autologous and implant-based reconstruction accounted for 36.4% and 63.6% of all breast reconstruction surgeries, respectively. However, there was a rapid increase in the annual growth of 28% in the use of implant-based reconstruction, surpassing that of autologous tissue reconstruction. By 2020, the proportion of autologous reconstructions had decreased to 11.1%, while that of implant-based reconstructions had substantially increased to 88.9%. Consequently, the noteworthy rise in TM rates likely corresponds to an increase in subcutaneous mastectomies. The observed trend was similar to the surgical pattern observed among patients with invasive breast cancer. In comparison with the 2-year interval preceding April 2015, over the 2-year period following April 2015, there was a statistically significant surge in TM rates (41.9% *vs.* 36.6%) and a corresponding significant increase in the proportion of prosthesis-based reconstructions among those who underwent immediate breast reconstruction (67.5% *vs.* 44.6%) (20). Implant-based breast reconstruction has a disadvantage: it can result in a less natural breast shape than autologous tissue reconstruction and is susceptible to late capsular contracture related to radiation (21). Advancements in synthetic materials have significantly improved breast shape preservation, leading to increased acceptance and utilization of implant-based reconstruction (22). A common strategy involves inserting an expander during the initial surgery, followed by post-mastectomy RT and a two-stage implant exchange operation (23). Immediate implant reconstruction is a favorable option, especially in cases of DCIS, where adjuvant RT is rarely utilized. Implant-based reconstruction offers notable benefits, including short surgical and recovery

Table 4 ORs for omitting RT and hypofr RT

Variables	RT omit *vs.* RT				Conv RT *vs.* hypofr RT			
	RT omit	RT	OR (95% CI)	P	Conv RT	Hypofr RT	OR (95% CI)	P
Treatment period								
2009–2014	3,003	5,313			4,686	495		
2015–2020	9,281	9,577	1.15 (1.13–1.16)	<0.001	5,711	3,419	1.12 (1.1–1.13)	<0.001
Combined age (years)								
<70	11,357	14,229			10,067	3,716		
≥70	877	661	1.18 (1.15–1.22)	<0.001	330	198	1.1 (1.07–1.13)	<0.001
Axillary surgery								
No	7,032	8,366			5,931	2,104		
Yes	5,252	6,524	1.04 (0.99–1.1)	–	4,466	1,810	1.14 (1.06–1.23)	0.001
Region of surgery† I								
Non-Seoul	7,035	8,157			5,947	2,688		
Seoul	5,249	6,733	–	–	4,450	1,226	0.98 (0.97–1)	0.008
Region of surgery† II								
Non-capital	4,057	4,664			3,138	1,361		
Capital area	8,227	10,226	0.95 (0.93–0.96)	<0.001	7,259	2,553	1.04 (1.03–1.06)	<0.001
Region of surgery† III								
Non-metropolitan	1,109	1,819			1,090	597		
Metropolitan	11,175	13,071	1.16 (1.14–1.19)	<0.001	9,307	3,317	0.98 (0.96–1)	0.082
Size of hospital of surgery‡								
<800 beds	5,032	5,478	1.06 (1.04–1.07)	<0.001	4,003	1,243	0.99 (0.97–1)	0.016
≥800 beds	7,252	9,412			6,394	2,671		
RT technique								
3D	–	–			10,314	1,921		
IMRT	–	–	–	–	83	1,993	2.12 (2.08–2.15)	<0.001

Data are presented as number, unless otherwise indicated. †, region of RT for hypofr RT analysis; ‡, size of hospital of RT for hypofr RT analysis. OR, odds ratio; RT, radiation therapy; conv, conventional fractionation; hypofr, hypofractionated; CI, confidence interval; 3D, three-dimensional; IMRT, intensity-modulated RT.

durations (24); it also eliminates the need for additional hospital visits for RT. As we navigate the challenges posed by the pandemic, it is imperative to monitor and observe evolving trends in breast reconstruction treatments. This proactive approach will optimize patient care and achieve favorable outcomes.

In the later treatment periods, especially after 2018, there was a significant increase in the use of hypofractionated RT, accounting for over half of the patients receiving RT. Clinical evidence and the establishment of hypofractionated RT as a standard treatment for invasive carcinoma are considered the main factors contributing to the growing adoption of hypofractionated RT. In 2018, the American Society for Radiation Oncology (ASTRO) revised its guidelines to advocate for the use of HF-WBI as a viable treatment option for DCIS. Although comprehensive randomized controlled trials (RCTs) targeting pure DCIS cases are lacking, the evidence from RCTs on micro-invasive carcinoma, observational approaches, and population-based studies cumulatively provides robust support for the application of hypofractionation in DCIS treatment (8). Subsequently, a clinical trial conducted by the Trans-Tasman Radiation Oncology Group (TROG) in Australia and New Zealand compared HF-WBI and CF-WBI in DCIS. The trial revealed no statistically significant disparities in the 5-year rates of freedom from local recurrence between CF-WBI (94.9%) and HF-WBI (94.9%) groups (25). The Danish Breast Cancer Group (DBCG) HYPO trial randomized women with adenocarcinoma or DCIS to receive 50 Gy in 25 fractions or 40 Gy in 15 fractions. Among the 246 DCIS patients, locoregional recurrence was observed in 7.7% of cases, with no discernible distinction between the treatment groups [hazard ratio (HR), 1.40; 95% confidence interval (CI): 0.49–4.05; P=0.053] (26). In South Korea, the cost analysis indicates that hypofractionated RT (42.56 Gy/16 fractions) led to a significant saving of 675.64 US dollars (USD) (26.6% reduction) compared to conventional fractionation RT (50.4 Gy/28 fractions). The reduction in patient out-of-pocket costs is approximately 34.80 USD. Furthermore, the adoption of hypofractionated RT has the potential to further decrease indirect costs by shortening the treatment period to 2 weeks (27). In the later part of our study, an increasing trend was observed among Korean women with DCIS who underwent BCS and opted to omit RT. Notably, this trend was prominent among elderly individuals and those treated at metropolitan surgical centers. Unfortunately, factors crucial for the decision to omit RT, such as histological grade, size, and diagnostic approach, could not be analyzed from the available dataset. In the US, during the COVID-19 pandemic, omission of RT was recommended for patients with mammographically detected lesions <2.5 cm, low- or intermediate-grade tumors, adequate margins (≥2 mm), and those aged over 40 years (28). Notably, this recommendation is specific to unique circumstances. Recent prospective studies have suggested omission of RT for individuals classified in the “good risk group”; hence, caution is required when advising omission. The Radiation Therapy Oncology Group (RTOG) 9804 identified good-risk patients as those with mammographically detected low- or intermediate-grade DCIS measuring less than 2.5 cm, with margins ≥3 mm (29). The trial compared the outcomes of RT *vs.* observation after surgery. The 7-year results indicated a low ipsilateral local failure rate in both arms (0.9% in the RT arm and 6.7% in the observation arm); however, the RT arm had a significantly low failure rate (HR, 0.11; P<0.001). Notably, for patients with high nuclear grade and large tumor size and young patients, the addition of RT should be considered, as it can significantly affect overall survival (6). Currently, three clinical trials [COMET in the USA, LORIS in the UK, and LORD in The Netherlands/European Union (EU)] are actively recruiting patients to address this nuanced issue (30-32).

Our study has several limitations. First, the retrospective nature of our analysis of a national claims database may have led to potential bias and incomplete clinical information. An example is the possible misclassification of lumpectomy patients who underwent surgery in December using N7135 code and received RT in the subsequent year, potentially leading to misrepresentation as mastectomy cases. Second, certain key factors that influence the decision, such as histological grade, tumor size, and diagnostic approach, could not be assessed. The database lacks detailed information on patient preferences, socioeconomic statuses, and genetic profiles, which could affect treatment choices. Considering the generalizability of our findings in a clinical context, the lack of specific individualized treatment data emphasizes the need for further research to tailor therapeutic approaches to individual patients.

Conclusions

In conclusion, our study provides insights into the changing treatment landscape of DCIS in South Korea. We observed an increasing trend in breast surgeries for DCIS, particularly BCS, and increased utilization of implant-based breast reconstruction. The use of RT has also evolved, with a notable increase in hypofractionated RT and omission of RT. While recommendations for RT omission exist, caution is advised, and decisions should be tailored to individual patient factors and tumor characteristics. As we navigate the complexities of breast cancer treatment, continuous monitoring and analysis of evolving trends are crucial for optimizing patient care and outcomes. Efforts to further understand the impact of treatment decisions and to explore novel approaches through ongoing clinical trials will contribute to advancements in DCIS management.

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Footnote

Reporting Checklist: The authors have completed the

STROBE reporting checklist. Available at https://gs.amegroups.com/article/view/10.21037/gs-23-433/rc

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://gs.amegroups.com/article/view/10.21037/gs-23-433/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work, and ensure that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study was conducted in accordance with the Declaration of Helsinki (revised in 2013). The study was approved by the Institutional Review Board of Pusan National University Yangsan Hospital (IRB No. 05-2022-128), and the requirement for individual consent for this retrospective analysis was waived.

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