Annals of Medicine and Surgery 60 (2020) 365–371

Contents lists available at ScienceDirect

Annals of Medicine and Surgery

journal homepage: www.elsevier.com/locate/amsu

Cohort Study

Outpatient breast-conserving surgery for breast cancer: Use of local and intravenous anesthesia and/or sedation may reduce recurrence and improve survival

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ARTICLE INFO

Keywords:
Breast cancer
Outpatient surgery
Breast-conserving surgery
Anesthetic technique
Breast cancer recurrence

ABSTRACT

Background: The use of general anesthesia (GA) with inhalational anesthetics for breast cancer surgery may be associated with breast cancer recurrence and increased mortality due to the immunosuppressive effects of these drugs. Less-immunosuppressive anesthetic techniques may reduce breast cancer recurrence. We evaluated the feasibility, safety, and efficacy of outpatient breast-conserving surgery (BCS) for breast cancer in a breast clinic in terms of the anesthetic technique used, complications occurring, recurrence, and survival. *Methods*: The sample comprised 456 consecutive patients with stage 0–III breast cancer who underwent BCS/axillary lymph node (ALN) management using local and intravenous anesthesia and/or sedation between May 2008 and January 2020. Most patients received adjuvant chemotherapy and/or endocrine therapy and radiotherapy after surgery. Patient outcomes were evaluated retrospectively. *Results:* All patients recovered and were discharged after resting for 3–4 h postoperatively. No procedure-related severe complication or death occurred. Sixty-four complications (14.0%) were observed: 14 wound infections, 17 hematomas, and 33 axillary lymphoceles. The median follow-up period was 2259 days (range, 9–4190 days), during which disease recurrence was observed in 25 (5.4%) patients. The overall survival and breast cancer–specific survival rates were 92.3% and 94.7%, respectively. *Conclusions:* Outpatient surgery for breast cancer involving BCS and ALN management under local and intravenous anesthesia and/or sedation can be performed safely, without serious complication or death. Less-immunosuppressive anesthetic techniques with spontaneous breathing may reduce the recurrence of breast cancer and improve survival relative to GA.

1. Introduction

Advances in anesthesia and the de-escalation of breast cancer surgery have enabled the performance of breast-conserving surgery (BCS) and axillary lymph node (ALN) management techniques, such as sentinel lymph node biopsy (SLNB) and axillary lymph node dissection (ALND), in outpatient settings for patients with breast cancer [1,2]. In addition, the paradigm shift from adjuvant chemotherapy to neo-adjuvant chemotherapy (NAC) has not only improved the prediction of prognosis and treatment response, but also reduced the size of the resected area due to post-NAC downstaging of advanced breast cancer [3].

Although the performance of outpatient BCSs and mastectomies (MTs) under general anesthesia (GA) began in the United Sates in the mid-1990s [4–6], and outpatient treatment is now the standard BCS approach in the United States and Europe, it is not yet the standard in Japan, where BCS remains an inpatient procedure performed under GA. BCS can feasibly be performed using local or intravenous (IV) anesthesia with propofol and/or sedation with ALN management by SLNB and/or limited ALND, and it is associated with less immunosuppression than GA induced with volatile anesthetics and opioids [7,8]. Although the survival benefit of day BCS in patients with breast cancer has not been determined, several retrospective analyses have shown that BCS improves overall survival (OS) and breast cancer–specific survival (BCSS)

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https://doi.org/10.1016/j.amsu.2020.10.072
Received 28 August 2020; Received in revised form 30 October 2020; Accepted 31 October 2020
Available online 6 November 2020
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relative to MT [9,10]. The reasons for this superior survival benefit are unknown, but an adjusted analysis indicated that the benefit is not likely due to the tumor or clinical characteristics of the BCS and MT groups [11]. Rather, greater surgical stress in the MT group than in the BCS group may result in increased immunosuppression. The contributions of GA use and surgical stress to immunosuppression may result in increased mortality associated with breast cancer recurrence after surgical treatment [12]. In this retrospective cohort analysis, breast cancer recurrence and associated mortality were examined in a sample of 456 consecutive patients with breast cancer undergoing BCS and ALN management under local and IV anesthesia and/or sedation in the outpatient setting of a breast clinic. We hypothesized that the use of less-immunosuppressive anesthetic approaches with local and IV anesthesia and/or sedation with the maintenance of spontaneous breathing would improve the survival of patients with breast cancer.

2. Methods

2.1. Patients

The study sample comprised female patients diagnosed with primary breast cancer (Union for International Cancer Control TNM stages 0–III) in our breast clinic who underwent outpatient BCS under local and IV anesthesia and/or sedation between May 2008 and January 2020. Patient selection and preoperative assessment for outpatient surgery considered patients' preferences; general health in terms of physical, psychological, and social conditions; and oncological suitability. The decision to perform outpatient surgery was made following discussions among the patients, their family members, and the surgeon. Patients who preferred inpatient surgery were referred to desired or partner hospitals.

2.2. Anesthetic and surgical techniques

Following a local infiltrative anesthesia approach, each patient was administered 30–80 ml 0.5% lidocaine in the breast region and 10 ml 1% lidocaine in the axillary region in combination with IV propofol (induction, 1 mg/kg; maintenance, 6–8 mg/kg/h) or propofol (maintenance, 2–3 mg/kg/h) and midazolam (1.5–2.5 mg/injection). We preoperatively administered a local injection of 10 ml 0.5% lidocaine into the retro-tumor space under ultrasound guidance when marking the area of tumor resection, and then administered additional local injections in the peritumor area before and during surgery. For analgesia, the opioid receptor (OR) partial agonist pentazocine (15 mg, IV) or the synthetic opioid pethidine (35 mg, IV) was administered. In the first part of the study period (until December 2008), outpatient surgery with partial resection of the breast (Bp)/SLNB was initiated in 21 patients with local lidocaine and/or an OR agonist. For IV sedation (to eliminate patient anxiety and facilitate surgery), diazepam was initially used (in four patients until April 2009); we then switched to midazolam or a combination of the two drugs to obtain greater sedation during surgery. In October 2011, the anesthetic sedation approach was shifted to IV propofol administration, which permitted more stable sedation and rapid awakening; the approach then proceeded to combined sedation with midazolam (1.0–1.5 mg/injection) and low-dose propofol (2–3 mg/kg/h). For analgesia, we initially used an OR partial agonist, then switched to pethidine to provide more analgesia during surgery. However, given that the combination of propofol and pethidine produced bronchospasm in two patients, we switched from pethidine back to the OR partial agonist in combination with propofol and midazolam. For vital function monitoring during surgery, patients were fitted with biometric information monitors that measured the pulse rate, electrocardiographic activity, blood pressure, respiratory rate, and oxygen saturation. All patients received 3–5 l/min oxygen via nasal probe during surgery in preparation for mask ventilation and tracheal intubation in an emergency.

All patients underwent BCS consisting of Bp with SLNB and/or ALND. The same surgeon performed all surgical procedures in the clinic. BCS was defined as Bp with primary tumor resection and a margin 1–1.5 cm from the tumor. Axillary SLNB was performed using the dye method with indigo carmine alone or in combination with indocyanine green (to increase the accuracy of SLN identification, beginning in August 2011). Initially, the SLNs were prepared as permanent sections and sent to the Fukuyama Medical Laboratory (Fukuyama, Japan) for pathological diagnosis, as intraoperative pathological diagnosis was not available in the clinic. When SLN metastasis was detected in a permanent section after surgery, additional ALND in a secondary operation was performed or adjuvant chemotherapy was administered, depending on the number of lymph nodes involved and the patient's preference. From April 2013, one-step nucleic acid amplification (OSNA) [13], which involves the measurement of cytokeratin 19 messenger RNA copy numbers in homogenized SLN samples to identify metastasis, was performed intraoperatively. When metastasis was detected by OSNA, ALND in the level I region without drain insertion was added continuously. In cases of axillary swelling with lymphocele formation after ALND, the lymphocele was punctured in the clinic. Based on the results of American College of Surgeons Oncology Group Z-0011 trial [14], ALND has not been performed for metastasis in one or two lymph nodes since August 2017. In the case of NAC, patients who were clinically node negative before chemotherapy received SNB, and patients who were clinically node positive before chemotherapy, as confirmed by fine-needle aspiration biopsy, underwent SLNB or ALND if they were clinically node negative after chemotherapy.

2.3. Postoperative care

Postoperatively, all patients were transferred from the operating room to recovery rooms. They were monitored intensively until complete awakening from IV anesthesia and/or sedation. After waking, they were monitored continuously until they were able to get up and sit in a reclining armchair. The patients then rested and walked before returning home, usually 3–4 h after surgery. Nonsteroidal anti-inflammatory and antiemetic drugs were administered to patients experiencing postoperative pain and nausea, respectively. After patients met the criteria for discharge in terms of vital signs and local findings, breast care nurses provided information on wound management, arm physiotherapy, and postoperative rehabilitative exercise of the diseased side. The surgeon reexamined patients prior to their discharge and again explained to them and their family members which anesthetics had been used and surgical procedures had been performed. Oral antibiotics and analgesics were prescribed for the prevention of wound infection and pain relief, respectively.

All patients and those responsible for escorting them home and providing home care received instructions regarding symptoms that might arise after they returned home. Patients and their family members were instructed to contact the surgeon via cell phone at any time when they noticed any abnormal condition, with back-up provided by partner hospitals. Patients who developed acute conditions requiring urgent management were transferred immediately to and treated effectively at partner hospitals. The patients were typically scheduled for two follow-up examinations in the clinic to check their wounds on postoperative days 1 or 2 and 7.

2.4. Systemic and local therapies

The patients received adjuvant therapy according to the tumor subtype and primary tumor pathological findings. Radiation therapy for the remaining breast was provided at partner hospitals using a standard dose or with additional boosters as needed, 3–4 weeks (for hypofractionated doses) or 4–5 weeks after surgery or adjuvant chemotherapy. When needed, neoadjuvant therapy (chemotherapy or endocrine therapy) was given for 6 months before surgery. All patients with stage III disease and some with stage II disease received NAC preoperatively.

2.5. Survival analysis

All data were analyzed using Statcel 4 (OMS Publishing Inc., Saitama, Japan). Cumulative OS and BCSS rates, and survival rates by pathological stage (pStage) and tumor subtype, were calculated using the Kaplan–Meier method. Data were compared among groups using the log-rank test. P values < 0.05 were considered to be significant.

3. Results

3.1. Patient characteristics

A total of 456 consecutive patients with breast cancer underwent BCS at the breast clinic during the 11.4-year period. The median follow-up period was 2259 days (range, 9–4190 days). The median age of the patients was 50 years (range, 27–91 years). The clinicopathological characteristics of the patients are summarized in Table 1. In terms of clinical stage, 267 (58.4%) patients had stage 0 or I disease, 165 (36.1%) patients had stage II disease, and 24 (5.2%) patients had stage III disease. In terms of pathological tumor size, nine (1.9%) patients with pT0 had complete responses following NAC. Pathological ALN metastasis was observed in 105 (22.9%) patients. In the remaining 349 (76.5%) patients, no metastasis was observed, which was defined as pN0. In terms of tumor subtype, 325 (71.2%) patients had hormone receptor–-positive and human epidermal growth factor receptor 2 (HER2)-negative tumors, 58 (12.6%) patients had HER2-positive tumors, and 17 (3.7%) patients had triple negative (TN) breast cancer.

3.2. Anesthetic techniques

The anesthetic techniques used for surgery are summarized in Table 2. The most frequently used anesthetic approach was lidocaine/propofol/midazolam/pentazocine [n = 165 (36.1%)], followed by lidocaine/benzodiazepine/pethidine [n = 132 (28.9%)] and lidocaine/propofol/pethidine [n = 94 (20.6%)]. In total, 250 (54.8%) patients received pethidine and 189 (41.1%) patients received pentazocine.

3.3. Neoadjuvant and adjuvant therapies

Seventy-two (15.7%) patients received NAC and 225 (49.3%) patients received adjuvant chemotherapy (Table 3). NAC was administered as combinations of taxanes, including paclitaxel (PTX), nanoparticle albumin-bound PTX, and docetaxel, with anthracyclines, such as 5-fluorouracil/epirubicin/cyclophosphamide (FEC) and epirubicin/cyclophosphamide. In HER2-positive patients, trastuzumab alone or in combination with pertuzumab was combined with taxanes. Node-positive patients and high-risk node-negative patients received adjuvant chemotherapy including combinations of anthracycline and taxanes. Other node-negative patients were treated with docetaxel/cyclophosphamide, PTX, or FEC. The oral fluoropyrimidine anticancer drugs tegafur-uracil and tegafur/gimeracil/oteracil were administered to 45 patients and 1 patient, respectively, who did not want to receive standard chemotherapy due to alopecia and intermediate risk. Because oncotype DX testing is not covered by the National Health Insurance in Japan, it was performed only for patients who wanted multigene assays, and adjuvant treatment was decided based on the results in these cases. Extended endocrine therapy was given depending on patient risk.

Table 1
Patient and tumor characteristics.

Clinicopathological characteristic	n (%) or median (range)
Age, years	50 (27–91)
Stage at diagnosis	
0	19 (4.1)
I	248 (54.3)
II	165 (36.1)
III	24 (5.2)
Pathological tumor size	
T0	9 (1.9)
Tis	65 (14.2)
T1	295 (64.6)
T2	82 (17.9)
T3	5 (1.0)
Pathological nodal status	
N0	349 (76.5)
N1	98 (21.4)
N2	7 (1.5)
Unknown	2 (0.4)
Tumor histology	
IDC	333 (73.0)
ILC	10 (2.1)
Other IDC	40 (8.7)
NIDC	64 (14.0)
Nuclear grade	
I	469 (10.7)
II	167 (36.6)
III	228 (50.0)
Unknown	3 (0.6)
Subtype	
HR positive/HER2 negative	325 (71.2)
HR positive/HER2 positive	48 (10.5)
HR negative/HER2 positive	10 (2.1)
Triple negative	17 (3.7)
Surgery type	
Bp/SLNB	348 (76.3)
Bp/SLNB/ALND	29 (6.3)
Bp/ALND	55 (12.0)
Other	24 (5.2)
Neoadjuvant therapy	72 (15.7)
Adjuvant chemotherapy	225 (49.3)
Postoperative radiotherapy[a]	405 (88.8)
Disease recurrence	25 (5.4)
First metastasis site	
Locoregional	9 (36.0)
Bone	1 (4.0)
Visceral	6 (24.0)
Brain	2 (8.0)
Multiple	7 (28.0)

IDC: invasive ductal carcinoma, ILC: invasive lobular carcinoma, NIDC. Noninvasive ductal carcinoma, HR: hormone receptor, HER2: human. Epidermal growth factor receptor 2, Bp: partial breast resection, SLNB. Sentinel lymph node biopsy, ALND: axillary lymph node dissection.
[a] Unknown for seven cases.

Table 2
Anesthetic techniques.

Anesthesia/sedation/analgesia	n (%)
Lidocaine/benzodiazepine/pethidine	132 (28.9)
Lidocaine/benzodiazepine/pentazocine	13 (2.8)
Lidocaine/propofol/pethidine	94 (20.6)
Lidocaine/propofol/pentazocine	3 (0.6)
Lidocaine/propofol/midazolam/pethidine	24 (5.2)
Lidocaine/propofol/midazolam/pentazocine	165 (36.1)
Others	25 (5.4)

Benzodiazepine: midazolam and/or diazepam.

3.4. Surgical and anesthetic complications

Surgical and anesthetic complications are listed in Table 4. Wound infection was observed in 14 (3.0%) patients, possibly due to the retention of absorbent agents, such as surgical and vicryl meshes, in the resected areas in eight of these patients. Following the identification of this complication, mesh insertion was aborted. Postoperative hematoma was observed in 17 (3.7%) patients, four of whom underwent reoperation 5–7 days after surgery to stop subcutaneous bleeding. Axillary lymphoceles were observed in 33 (7.2%) of the 84 patients undergoing limited ALND without axillary drainage; these lymphoceles disappeared after several aspirations, and no case required continued management

Table 3
Adjuvant and neoadjuvant chemotherapy regimens.

Regimen	Adjuvant chemotherapy, *n* (*n* combined with Tz)	Neoadjuvant chemotherapy, *n* (*n* combined with Tz)
PTX/EC	3 (1)	0
PTX/FEC	29 (3)	15 (1)
nab-PTX/FEC	8 (2)	23 (9)
DTX/FEC	37 (6)	17 (4)
PTX	8 (5)	0
FEC	26 (2)	0
TC	55 (7)	0
Tz	1	0
TS-1	1	0
UFT	45 (1)	0
ANZ/Tz	0	1
ddEC/nab-PTX	0	1
ddEC/ddnab-PTX	0	2
EC	0	1
EC/DTX	4	8 (1)
EC/nab-PTX	0	2
EC/PTX	7 (2)	1
EC/H-PD	1	0
FEC/nab-PTX	0	1 (1)

PTX: paclitaxel, EC: epirubicin/cyclophosphamide, FEC: epirubicin/5-fluorouracil/cyclophosphamide, nab: nanoparticle albumin-bound, DTX: docetaxel, TC: docetaxel/cyclophosphamide, Tz: trastuzumab, TS-1: tegafur/gimeracil/oteracil, UFT: tegafur/uracil, ANZ: anastorozole, dd: dose-dense, H-PD: trastuzumab/pertuzumab/docetaxel.

after surgery. Regarding anesthetic complications, bronchospasm was observed in two (0.4%) patients, probably due to the combed use of propofol and pethidine. Both patients recovered with oxygen administration without tracheal intubation after propofol discontinuation. Postoperative nausea and vomiting were observed in 25 (5.4%) patients who had received diazepam/midazolam and/or OR partial agonist or pethidine. They were resolved with antiemetic agents, and the subsequent use of propofol-based sedation reduced these complications. No patient revisited the clinic or was referred to a partner hospital due to a postsurgical complication, such as bleeding or an anesthesia-related event after discharge.

3.5. Clinical outcomes and survival

During follow-up, locoregional and/or distant recurrence was detected in 25 (5.4%) patients. Among these cases, locoregional recurrence was observed in nine patients (local recurrence, $n = 6$; regional lymph node recurrence, $n = 3$). In addition, one bone metastasis, six visceral metastases, and two brain metastases were detected. Seven patients had multiple metastases. Eighteen deaths occurred related to breast cancer ($n = 12$) and other conditions ($n = 6$). In addition to one post-NAC noninvasive ductal carcinoma, 16 patients had luminal (L), six patients had HER2-positive, and two patients had TN breast cancer. The OS rate for the total cohort was 92.3%; OS rates for pStages 0–III disease were 93.5%, 94.1%, 90.0%, and 71.4%, respectively ($P = 0.017$). OS rates for L, L-HER2, HER2, and TN breast cancers were 93.4%, 93.1%, 83.3%, and 64.2%, respectively ($P = 0.002$; Fig. 1). The BCSS rate for the total cohort was 94.7%; BCSS rates for pStages 0–III disease were 97.9%, 95.9%, 92.7%, and 71.4%, respectively ($P = 0.001$). BCSS rates for L, L-HER2, HER2, and TN breast cancers were 94.8%, 93.1%, 83.3%, and 83.3%, respectively ($P = 0.130$; Fig. 2).

Table 4
Surgical and anesthetic complications.

C Complication	*n* (%)
Wound infection	14 (3.0)
Hematoma	17 (3.7)
Axillary lymphocele	33 (7.2)
Bronchospasm	2 (0.4)
Nausea/vomiting	25 (5.4)

4. Discussion

The findings of this study demonstrate the feasibility, safety, and efficacy of BCS with SLNB and/or limited ALND using local and IV anesthesia and/or sedation for patients with breast cancer in the outpatient setting of a breast clinic. This approach maintains spontaneous breathing, in contrast to GA, which permits patient recovery and discharge within 3–4 h postoperatively due to the reduced physical demand of the surgery. The present study expands on our first study of outpatient surgery for breast cancer, which involved 370 patients followed for a median of 1580 days (range, 12–3076 days) [7]. Breast cancer recurrence was detected in 21 (5.6%) patients in that sample. With a larger sample and follow-up duration that exceeded 10 years in some cases, the present study confirmed that outpatient surgery under local and IV anesthesia and/or sedation reduced the recurrence of breast cancer and conferred a survival benefit.

The efficacy of such outpatient surgery for breast cancer is reflected by the postoperative recurrence rate, which has been reported to be about 20% at 10 years after diagnosis [15,16]; the recurrence rate of 5.4% at 11.4 years in this study is much lower. Our OS and BCSS results were also superior to those reported previously, including 10-year OS rates for stages II and III of 80% and 60%, respectively, and 10-year BCSS rates for L, L-HER2, HER2, and TN breast cancers of 79%, 60%, 55%, and 67%, respectively [17,18], likely reflecting the benefit of the anesthetic and surgical approaches used in our cases. BCSS reflects the efficacy of breast cancer treatment more accurately than does OS, and it tended to outperform OS in our sample. Importantly, no significant difference in BCSS according to tumor subtype was observed in this study.

Regarding the effects of anesthetic agents on cancer and immune cells, lidocaine inhibits tumor cell invasion at surgical concentrations [19], and propofol protected immune cells in an experimental model [20]. Midazolam has anti-inflammatory action via the inhibition of nitric oxide synthase and cyclooxygenase-2 [21]. In general, synthetic and other opioids (e.g., morphine) and volatile anesthesia exert immunosuppressive effects [22–24]. The relationship between the anesthetic technique used and breast cancer recurrence has been a controversial issue in oncological surgery, as previous retrospective studies have yielded both positive and negative results [25]. A recent, large, prospective randomized trial comparing the use of volatile anesthesia with sevoflurane/morphine with the use of paravertebral anesthesia/propofol or deep sedation for MT or BCS with ALND found no significant difference in breast cancer recurrence at a median of 3 (maximum, ~7) years overall, but subgroup analyses revealed potentially reduced risks of recurrence in patients undergoing BCS and in Asian patients receiving paravertebral and propofol anesthesia [26]. At our clinic, we replaced the use of pethidine, a synthetic opioid, with the use of the OR partial agonist pentazocine to avoid immunosuppressive effects, although changes in the immune response to the increased number of B lymphocytes and reduced phytohaemagglutinin and tuberculin responses after premedication with pethidine are not clinically important [27]. The mechanism by which the maintenance of spontaneous breathing affects immunity is unknown but may involve reduced activation of the hypothalamus-pituitary-adrenal (HPA) axis, and thus reduced immunosuppression and perioperative breast cancer recurrence [28,29]. Immunosuppression and neuroendocrine mediation via the HPA axis have also been suggested to increase distant metastasis from residual tumor cells, circulating tumor cells, and preexisting micrometastasis after surgery [30].

A potential limitation of BCS with ALN management under local and IV anesthesia and/or sedation is the insufficiency of such anesthesia for

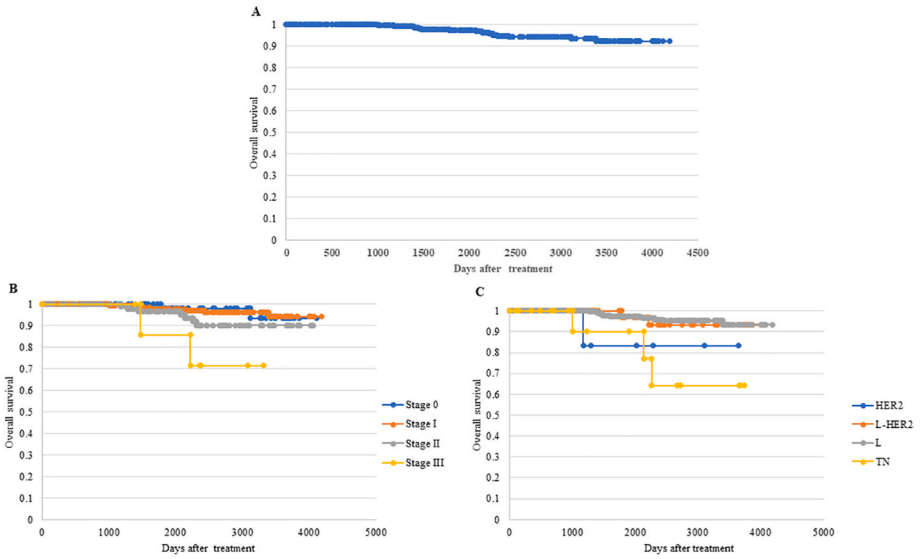

Fig. 1. Cummulative overall survival curves for patients with breast cancer who underwent breast-conserving surgery in an outpatient setting with local and intravenous anesthesia and/or sedation, for the total cohort ($n = 456$; A) and by pathological stage (B) and tumor subtype (C). "Days after treatment" refers to the number of days after surgery or systemic treatment. L, luminal; HER2, human epidermal growth factor receptor 2; TN, triple negative.

surgical treatment in patients with large breasts; ethnic differences in breast size may also exist. In such cases, surgery may require the addition of a paravertebral block or GA.

Day surgery under GA is the standard for breast cancer surgery in some parts of Asia [31]; the reasons underlying its lack of widespread use in Japan are probably not related to technical or anesthetic problems. National Health Insurance covers medical expenses for all patients in Japan with limited payments, and most breast surgery is performed as inpatient treatment at core hospitals. Some patients also have private health insurance and wish to maximize the classification of their medical costs as inpatient care. In addition, many patients believe that inpatient surgery for breast cancer is safer than outpatient surgery, although this is not the case. Outpatient breast cancer surgery should become widespread in Japan in the near future, as it could reduce national healthcare costs and improve the survival of patients with breast cancer.

Breast cancer surgery has shifted to de-escalation surgeries, such as BCS and/or SLNB; eventually nonsurgical treatment may be possible [32–34]. The development of molecular targeted therapies has escalated with neoadjuvant and adjuvant therapies to improve the survival of patients with breast cancer [35]. The surgical treatment of breast cancer can be minimized via the choice of surgical procedures and anesthetic techniques that cause less immunosuppression and potentially contribute to survival benefits by reducing breast cancer recurrence. This study does not directly demonstrate that the low recurrence and improved survival rates for patients undergoing BCS in an outpatient setting are due to the use of less-immunosuppressive anesthetic techniques with local and IV anesthesia and/or sedation relative to GA because the patients were selected and the study design was not prospective or controlled. Prospective randomized controlled trials (RCTs) are needed to elucidate the survival benefit of anesthetic techniques with local and IV anesthesia under spontaneous breathing relative to GA in the context of BCS for breast cancer. Given that BCS and ALN

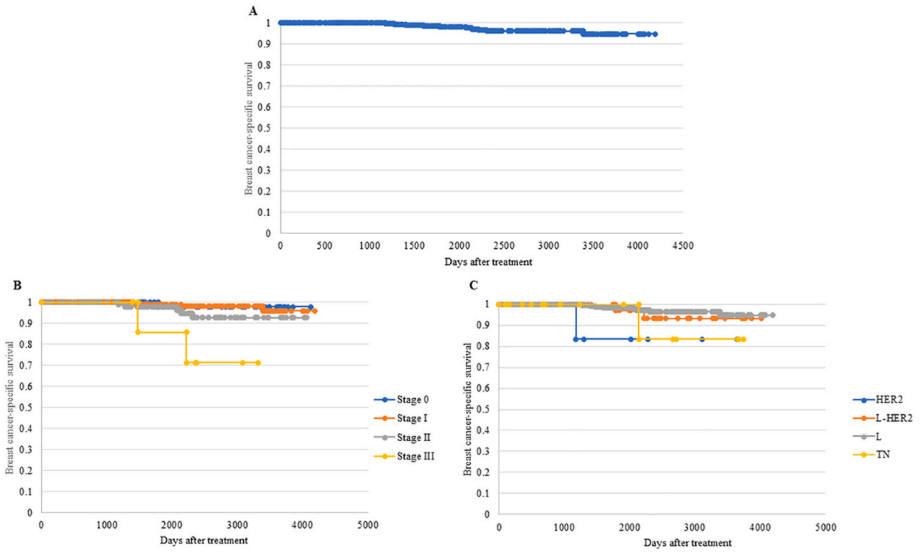

Fig. 2. Cummulative breast cancer–specific survival curves for patients with breast cancer who underwent breast-conserving surgery in an outpatient setting with local and intravenous anesthesia and/or sedation, for the total cohort ($n = 456$; A) and by pathological stage (B) and tumor subtype (C). "Days after treatment" refers to the number of days after surgery or systemic treatment. L, luminal; HER2, human epidermal growth factor receptor 2; TN, triple negative.

management has been performed for breast cancer in the outpatient setting only under local and IV anesthesia and/or sedation since its introduction, this study lacked a control arm of patients who received GA with inhalational anesthetics. Patients who have undergone tracheal intubation under IV anesthesia with opioids such as fentanyl and remifentanil and who did not receive local anesthesia would form the best control group in an RCT for comparison with our anesthetic technique. Such research will reveal the significance of spontaneous breathing maintenance and the influence of opioids on recurrence and survival in patients who have undergone BCS and ALN management for breast cancer. This paper has been reported in line with the STROCSS guideline [36].

5. Conclusion

Outpatient surgery for breast cancer involving BCS and ALN management under local and IV anesthesia and/or sedation can be performed safely without serious complication or death. Based on our experience with anesthetic techniques, we determined that local anesthesia with lidocaine and IV anesthesia with low-dose propofol (2–3 mg/kg/h), with midazolam (1.0–1.5 mg/injection) for sedation and an OR partial agonist, under spontaneous breathing is the most suitable approach for outpatient surgery for breast cancer, as it provides good control of the sedation level during surgery based on each patient's age and weight. Breast cancer surgery consisting of BCS and ALN management with less-immunosuppressive anesthetic techniques may reduce the recurrence of breast cancer and improve survival compared with GA.

Ethical approval

This study was performed in accordance with the Declaration of Helsinki. The Ethics Committee of Hiroshima Mark Clinic (March 1, 2017) approved the study. All treatments were given with patients' informed consent.

Sources of funding

No funding was provided for this study.

Author contributions

Rungsa Kim designed and conceived the study and wrote the paper. Ami Kawai, Megumi Wakisaka, Sayaka Sawada, Mika Shimoyama, Naomi Yasuda, and Takanori Kin collected and assembled the data. Koji Arihiro performed the histopathological analysis of the vacuum-assisted biopsy samples and surgical specimens. Ryungsa Kim and Ami Kawai analyzed and interpreted the data. All authors agree with the final version of the paper and provide their consent for publication.

Registration of research studies

1 Name of the registry: Researchregistry.com
2 Unique identifying number or registration ID: researchregistry5792
3 Hyperlink: https://www.researchregistry.com/browse-the-registry#home/

Guarantor

Ryungsa Kim, Ami Kawai, Megumi Wakisaka, and Takanori Kin.

Provenance and peer review

Not commissioned, externally peer reviewed.

Declaration of competing interest

The authors have stated that they have no conflict of interest.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.amsu.2020.10.072.

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