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Factors Preventing Prolonged Closed-Suction Drain Placement after Immediate Breast Reconstruction with Tissue Expanders

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Background: Prolonged drain placement occasionally causes complications such as infection in patients who have undergone implant-based breast reconstruction; therefore, the drainage period must be shortened to avoid complications.
Purpose: To identify the factors that prevent prolonged drain placement in patients who have undergone immediate breast reconstruction with tissue expanders.
Methods: This was a retrospective medical chart review of all patients who underwent immediate breast reconstruction with tissue expanders at a single center from April 2013 to March 2016. Closed-suction drains were placed in and on the implant pocket. An extra drain was positioned in the axilla in patients undergoing axillary lymph node dissection. The drains were removed at a drainage volume of ≤50 ml per 24 hours. Prolonged drain placement was defined as a period greater than the 75th percentile among all patients. Nine potential risk factors associated with prolonged drain placement were analyzed with multivariate logistic regression analysis.
Results: In total, 89 tissue expanders in 89 patients were placed in this study. Prolonged drain placement, determined as ≥9 days (range, 5–14 days), was significantly associated with body mass index ≥25 kg/m^2, tissue expander size ≥500 ml, and intraoperative bleeding ≥100 ml, in the multivariate analysis. Axillary lymph node dissection with extra-axillary drainage did not prolong the drainage period.
Conclusions: Our findings suggested that placing an extra-axillary closed-suction drain following axillary dissection, and reducing intraoperative bleeding and surgical trauma, could prevent prolonged drain placement in immediate breast reconstruction with tissue expanders.

INTRODUCTION

Closed-suction drain placement is considered effective in implant-based breast reconstruction; therefore, these drains are used often in this surgery. The timing of drain removal relies on the drainage volume, in most cases [1]; however, drain placement duration lengthens without a specific cutoff value, resulting in complications such as surgical-site infection [2-4], longer hospitalization periods [5], and frequent outpatient visits.

The duration of drain placement is critical in breast reconstruction, but few studies have evaluated the preventive factors for prolonged drainage duration, and some studies revealed only uncontrollable predictors. To avoid problems related to longer drainage duration, researchers must determine the surgically-controllable factors related to prolonged drain placement.

The present study aimed to identify factors preventing prolonged drain placement in patients undergoing immediate breast reconstruction with tissue expanders. To reveal preventable factors related to longer drainage duration, we included surgically-controllable factors, in this study.

MATERIALS AND METHODS

We performed a retrospective medical chart review that included all patients who underwent immediate breast reconstruction with tissue expanders (Natrelle® 133 tissue expanders; Allergan Inc., Irvine, CA, USA) from April 2013 to March 2016 at Shikoku Cancer Center. Because of the anonymous nature of the data, the requirement for

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informed consent was waived. The study information was open to the public on the web site of Shikoku Cancer Center, and study approval was obtained from the institutional review board of Shikoku Cancer Center (2016-112).

Surgical Technique

The size of the tissue expanders was determined with reference to the patient's breast width. We positioned the tissue expanders with an initial infusion of saline in the subpectoral space without an acellular dermal matrix implant. The lateral pocket was closed using a partial-thickness anterior serratus flap. The anterior sheath of the rectus abdominis was released at the bottom of the implant pocket, and closed-suction drains were placed in and on the implant pocket. Another indwelling drain was positioned in the axilla in patients who underwent axillary lymph node dissection. We also placed 2–3 suction drains.

Postoperative management

Drainage volume of each drain was measured separately and the drain was removed postoperatively when the volume reached ≤ 50 ml/24 hours. No additional infusion of saline into the tissue expander was performed until drain removal. Limited elevation and exercise of the arm ipsilateral to the reconstructed breast was required to reduce drainage volume while drains were in place.

Data Collection

All data were obtained from the clinical database of Shikoku Cancer Center. Information was collected on duration of drain placement; age; body mass index (BMI); history of smoking, diabetes mellitus, preoperative chest-wall irradiation, and neoadjuvant chemotherapy; mastectomy technique (traditional total mastectomy or nipple-sparing mastectomy); axillary operation (axillary lymph node dissection or sentinel lymph node biopsy); tissue expander size; intraoperative filling ratio; intraoperative bleeding; and operating time.

Cutoff Point Definition

Prolonged drainage duration was defined as a period greater than the 75th percentile among all patients. The following variables were divided into two groups: age (≥ 60 years vs < 60 years); BMI (≥ 25 kg/m^2 vs < 25 kg/m^2); mastectomy technique (nipple-sparing vs non-nipple-sparing); axillary lymph node dissection (performed vs not performed); tissue expander size (≥ 500 ml vs < 500 ml); intraoperative filling ratio (≥ 33.3 % vs < 33.3%); intraoperative bleeding (≥ 100 ml vs < 100 ml); and operation time (≥ 180 min vs < 180 min).

Statistical Analysis

Both univariate and multivariate logistic regression analyses were performed to identify factors associated with prolonged duration of the indwelling drain. Variables with fewer than eight events were excluded from this analysis because the sample size was considered insufficient for analysis.

We performed univariate logistic regression analysis to detect variables with a p-value <0.1. Only these variables were included in the subsequent multivariate logistic regression analysis, in which we applied the stepwise method using the p value. A p-value <0.05 was considered statistically significant, and all statistical analyses were performed using SPSS, version 24 (IBM Corp., Armonk, NY, USA).

RESULTS

Patients' Characteristics

Patients' characteristics are shown in Table I. During the study period, 99 procedures were performed in 99 patients. Patients with the following complications before drain removal were excluded from the study population because of the negative impact of these complications on the drainage volume: rupture of a tissue expander (n = 1), postoperative hematoma (n = 2), total necrosis of the nipple–areola complex (n = 2), and periprosthetic infection (n = 4). In cases of periprosthetic infection, infected tissue expanders, and drains were removed immediately without satisfying the criteria for drainage removal. In total, 89 tissue expanders in 89 patients were included in this study.

The 75th percentile of the drainage duration, which was our definition of prolonged drainage duration, was 9 days (range, 5–14 days). Thirty-two patients (36%) had prolonged drainage duration. Twelve patients (13%) were ≥ 60 years of age, and patients' age ranged from 22–72 years. Eighteen patients (20%) had a BMI ≥ 25 kg/m^2, and BMI ranged from 17.1–38.3 kg/m^2. The variables we excluded with fewer than eight events were history of diabetes mellitus, preoperative chest wall irradiation, and neoadjuvant chemotherapy.

Table I. Summary of patients' characteristics

Patients, n	89
Duration of drain placement, days	
Median, 75 percentile (range)	7.9, 9 (5–14)
≥9 days, n (%)	32 (36)
Age, years	
Median (range)	46.9 (22–72)
≥60 years, n (%)	12 (13)
BMI, kg/m2	
Median (range)	22.6 (17.1–38.3)
≥25 kg/m2, n (%)	18 (20)
Comorbidities, n (%)	
Smoker	8 (9.0)
Diabetes mellitus	2 (2.2)
Preoperative treatment, n (%)	
Chest-wall irradiation	0 (0)
Neoadjuvant chemotherapy	3 (3.4)

BMI, body mass index

Surgical Characteristics

Patients' surgical characteristics are shown in Table II. All breasts were resected for oncological reasons. Traditional total mastectomy (74/89; 83%) and sentinel lymph node biopsy (72/89; 81%) constituted the majority of the procedures. Sixteen patients (18%) underwent axillary lymph node dissection, and each of these patients had an extra drain placed in the resected axilla. Tissue expander size ranged from 250–700 ml, and in 17 patients (19%), the size was ≥ 500 ml. Intraoperative bleeding ranged from 10–370 ml, and the volume in 23 patients (26%) was ≥ 100 ml. Operating time ranged from 64–224 min, and was ≥ 180 min in 11 patients (12%). No variables included fewer than eight events; therefore, we included all surgical variables in the analysis.

Analysis

We analyzed nine variables. Univariate logistic regression analysis demonstrated that BMI ≥ 25 kg/m^2 ($p < 0.001$), axillary lymph node dissection ($p = 0.019$), tissue expander size ≥ 500 ml ($p < 0.001$), intraoperative blood loss ≥ 100 ml ($p < 0.001$), and operating time ≥ 180 min ($p = 0.004$) were associated with a drainage period of ≥ 9 days (Table III). Only these five factors had a p-value <0.1 and were included in the multivariate analysis.

Multivariate logistic regression analysis identified a significant association between drainage period ≥ 9 days and the following factors: BMI ≥ 25 kg/m^2 ($p = 0.005$; odds ratio [OR]: 8.02), tissue expander size ≥ 500 ml ($p < 0.001$; OR: 14.10), and intraoperative bleeding ≥ 100 ml ($p = 0.008$; OR: 5.57) (Table IV). In contrast, the association between axillary lymph node dissection and operating time ≥ 180 min was not statistically significant.

Table II. Summary of patients' surgical characteristics

Mastectomy technique, n (%)	
NSM	15 (17)
TTM	74 (83)
Axillary operation, n (%)	
ALND	16 (18)
SLND	72 (81)
None	1 (1.1)
TE size, ml	
Median (range)	300 (250–700)
≥500 ml, n (%)	17 (19)
Intraoperative filling ratio, %	
Median (range)	25 (10–50)
≥33.3 %, n (%)	34 (38)
Intraoperative bleeding, ml	
Median (range)	50 (10–370)
≥100 ml, n (%)	23 (26)
Operating time, min	
Median (range)	150 (64–224)
≥180 min, n (%)	11 (12)

NSM, nipple-sparing mastectomy; TTM, traditional total mastectomy; ALND, axillary lymph node dissection; SLND, sentinel lymph node biopsy; TE, tissue expander

Table III. Univariate logistic regression analysis of significant risk factors associated with a drain duration period of ≥9 days

Independent variable	Odds ratio	95% CI	p value
Age ≥60	1.96	0.58–6.69	0.282
BMI ≥25	10.3	3.00–35.40	< 0.001
Smoking history	3.33	0.74–15.00	0.117
NSM	1.23	0.39–3.84	0.721
ALND	3.86	1.25–11.90	0.019
TE size ≥500 ml	14	3.61–54.30	< 0.001
Intraoperative filling ratio ≥33.3 %	0.63	0.25–1.56	0.313
Intraoperative bleeding ≥100 ml	7.14	2.50–20.40	< 0.001
Operating time ≥180 min	10.8	2.16–53.70	0.004

CI, confidence interval; BMI, body mass index; TE, tissue expander; NSM, nipple-sparing mastectomy; ALND, axillary lymph node dissection

Table IV. Multivariate logistic regression analysis of significant risk factors associated with a drain duration period ≥ 9 days

Independent variable*	Odds ratio	95% CI	p value
BMI≥25	8.02	1.57–33.90	0.005
TE size≥500 ml	14.1	3.04–65.70	< 0.001
Intraoperative bleeding≥100 ml	5.57	1.57–19.90	0.008

CI, confidence interval; BMI, body mass index; TE, tissue expander

*A stepwise method using the p value was adopted in this analysis. We included variables with a p-value <0.1 in the univariate analysis.

DISCUSSION

This study investigated factors that prevented prolonged drain placement in patients who underwent immediate breast reconstruction with tissue expanders at a single cancer center. Our results showed that BMI ≥ 25 kg/m^2, tissue expander size ≥ 500 ml, and intraoperative blood loss ≥ 100 ml were independent risk factors for prolonged drain placement indicating that higher BMI and larger tissue expander size were predictors, and that intraoperative bleeding was a potential regulator of longer drainage periods. Despite evidence for a negative impact on drainage period in previous studies [6], our results indicated that placing an additional axillary drain did not prolong drainage duration in patients undergoing axillary lymph node dissection. Therefore, decreasing intraoperative blood loss and placing an axillary closed-suction drain after axillary lymph node dissection may help prevent prolonged drain placement in the patient group we studied. To our knowledge, findings regarding surgically-preventable factors and longer drainage duration have not been reported in previous studies.

Axillary drainage after axillary lymph node dissection has no specific guidelines, and the decision to place an axillary drain is left to each surgeon's discretion. However, we believe that placing an additional closed-suction drain in the resected axilla is essential in patients undergoing tissue expander-based breast reconstruction with axillary lymph node dissection. This procedure not only avoids postoperative seroma formation but also prevents prolonged drainage duration following breast reconstruction. Some studies reported that the number of drains did not affect postoperative seroma formation after axillary dissection [7, 8], but few studies have evaluated the relationship between the number of drains and the drainage period. In previous studies, patients undergoing tissue expander-based breast reconstruction without additional axillary drainage after axillary lymph node dissection suffered higher drainage volumes and longer drain placement [6]. Although the efficacy of axillary drainage for preventing seroma formation has been widely reported [9], no reports, to the best of our knowledge, suggested that an axillary closed-suction drain could rapidly reduce postoperative drainage following breast reconstructive surgery with axillary lymph node dissection.

Our results also suggested that intraoperative blood loss was a potential regulator of drainage duration; however, we determined that intraoperative blood loss was not a regulator of drainage duration but an indicator of surgical trauma. Depending on the extensiveness of a surgery, higher numbers of damaged blood vessels relates to higher numbers of damaged lymphatic vessels, which increases drainage volume and prolongs drain placement. Therefore, surgical trauma must be minimized, and intraoperative blood loss is an indicator of the degree of trauma. In our study, intraoperative blood loss ranged from 10–370 ml, which was excessive in some patients, and extensive surgical damage was expected. Further efforts to reduce intraoperative bleeding and surgical trauma are required.

Previous studies have shown predicable prolonged drain placement in implant-based breast reconstruction. A multivariate analysis showed that implant width was the only determinant of drainage period in patients undergoing breast reconstruction with Becker implants [10]. Another study reported that breast mass and body weight were predictors of drainage volume in expander-based breast reconstruction[6]. In axillary surgery, higher BMI correlated with increased mean daily axillary drainage and total drainage volume[11]. In the present study, larger tissue expander size and higher BMI, unalterable patient factors, were predictors of prolonged drain placement, similar to findings in previous reports.

There are several limitations in this study. The first is that our cutoff value of ≤ 50 ml drainage volume per 24 hours is less common than the value of ≤ 30 ml per 24 hours used by plastic surgeons [1]. However, surgeons adopt

criteria for drain removal using non-evidence-based, empirical criteria. We saw no seroma formation in the present study. In addition, our postoperative infection rate of 4.0% (4/99) was not as high as previously reported rates [4]. The second limitation is that our results were based on a retrospective medical chart review, which is not the most robust design for revealing risk factors. The third limitation is that the study population included exclusively Asian patients with no patients of European or African descent. Finally, we did not use acellular dermal matrix implants; thus, our findings may not be fully applicable to patients with partial muscle coverage over the tissue expanders with an acellular dermal matrix implant.

CONCLUSION

To the best of our knowledge, ours is the first study evaluating preventive factors for prolonged drain placement in immediate breast reconstruction with tissue expanders. We recommend placing a closed-suction drain with axillary lymph node dissection, and decreasing intraoperative blood loss and surgical trauma. Our analysis also suggested that higher BMI and larger tissue expander size were predictors of prolonged drain placement in patients undergoing this surgery.

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