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ARTICLE

Correction of malrotation in two-stage breast reconstruction: outcomes and risk-factor analysis

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ABSTRACT

Although an anatomical implant is no longer recommended in practice, frequent use of the implants in the past decade left apprehension to surgeons, and malrotation is one of the concerns. However, a limited amount of literature has focused on malrotation to date, especially in breast reconstruction, and there also exists a lack of consensus regarding the correction of malrotation. Given that implant-based reconstruction has increased in frequency and there remain many potential patients who have used earlier models of anatomical implants, this study sought to analyze predisposing risk factors and approaches to correct implant malrotation. A total of 132 implants in 118 patients who underwent expander/implant reconstruction were identified and retrospectively reviewed. Seventeen (12.9%) implants showed malrotation. The results of multivariate logistic regression revealed that tissue expander malrotation in the first stage and capsular contracture were significant risk factors associated with malrotation in two-stage implant-based breast reconstruction (both $p < 0.001$). When a patient presents with malrotation, it is recommended that the implant be changed to a round type if a patient has multiple risk factors because malrotation tends to recur after correction. Also, even when using a round implant during two-stage breast reconstruction, additional care should be adopted for those who experienced rotation after expander insertion.

Abbreviations: NSM: nipple sparing mastectomy; SSM: skin sparing mastectomy

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Breast reconstruction; implant reconstruction; malrotation; breast implant

1. Introduction

'Anatomical' or 'shaped' implants were developed to have a natural look [1,2]. However, the rotation of anatomical implants inevitably was a concern among surgeons due to the severe aesthetic consequences [2–6]. The incidence of malrotation reported in the literature varies from 1 to 14% [2–12]. Factors such as capsular contracture, pocket dissection, external pressure, intracapsular fluid, and preoperative breast volume have been described [7,8,13]. Despite the fact that breast implant-associated anaplastic large-cell lymphoma is currently the most vital issue to consider when choosing a type of implant, there remain many patients who might experience malrotation after frequent use of earlier-generation anatomical implants in the past decade. Also, there is still historical significance in addressing malrotation for the future of the implant industry.

Limited literature currently exists focusing solely on malrotation and most previous studies have focused on augmentation mammoplasty. Contours of implants are more noticeable in breast reconstruction cases and there is also a clear difference in surgical procedure between breast reconstruction and augmentation mammoplasty. As implant-based reconstruction increases in frequency, we thought that a comprehensive analysis of risk factors and standards to correct malrotation is needed. In addition, we found it necessary to challenge the ambiguity of malrotation, since many studies have not defined the term or even regarded it as a technical error.

Thus, the purpose of this study was to analyze predisposing risk factors of implant rotation including oncologic characteristics and to share outcomes of our institutional experience with conducting revisional surgery to correct malrotation.

2. Patients and methods

2.1. Definition of malrotation

Per our literature review, the term 'malrotation' does not seem to be clearly defined in many articles; for example, some articles do not distinguish it from 'malposition' [6,14]. We feel there should be a consensus about the definition because implants are mobile depending on patients' position and some surgeons do not place implants in the precise vertical angle for aesthetic purposes.

Considering the extent of malrotation in patients who symptomatically complained of it in our clinic, malrotation was defined as 'an implant altered more than 30 degrees of its vertical axis with the patient in an upright position with hands dropped naturally' in this study [15].

The evaluation of patients was done through both photographic analysis and physical examination. A palpable ridge (or midline indicator) of the anatomical implant was detected. If it was not palpable or malrotation was highly suspected, clinic-based ultrasonography detecting the midline indicator was used to confirm malrotation (Figure 1). The 'vertical axis' was drawn from the sternal notch to the umbilicus. The axis of the implant

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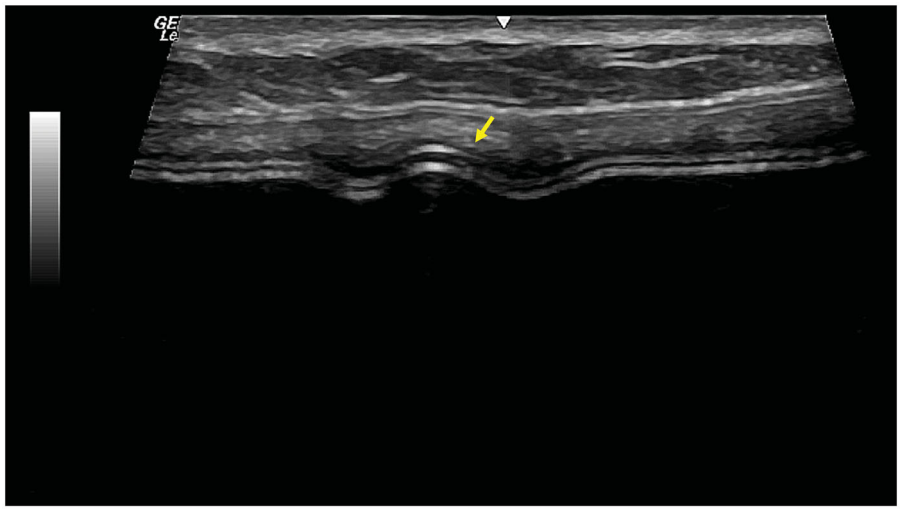

Figure 1. Ultrasonographic view of a silicone implant. Midline indicator or ridge (yellow arrow) was confirmed as being malpositioned more than 30 degrees off of the midline axis.

was drawn between the highest point of implant and a palpable midline landmark of the implant. Patients who underwent revisional surgery were carefully reviewed to establish the presence and degree of malrotation intraoperatively.

2.2. Patient selection

After obtaining approval for this study from our institutional review board (no. 2018AN0269), a retrospective chart review of patients who underwent two-stage implant-based breast reconstruction between January 2015 and April 2018 at a single clinic conducted by a single surgeon was performed. Patients with direct-to-implant reconstruction or with implants combined with an autologous flap were excluded. Tissue-expander insertion was done in the submuscular plane followed by the second stage of permanent implant change. Both concurrent reconstruction with mastectomy and delayed reconstruction were included. Tissue expanders were expanded at the rate of 50–100 ml every 2 weeks without any initial inflation. In the second stage of the operation, every patient underwent concomitant partial capsulectomy or capsulotomy. In our clinic, all two-stage breast reconstructions were performed with only anatomical implants during the study period. A routine drain was inserted and removed when the amount of drainage decreased to be less than 30 ml sequentially. All patients used garments for at least 6 weeks. Only patients with at least 1 year of follow-up were finally included in the study analysis. All patients were screened for malrotation in the outpatient clinic.

Among a total of 164 patients who underwent two-staged implant-based reconstruction, two cases of follow-up loss, 16 cases of patients yet to undergo second-stage implant change, and 28 cases with less than 1 year of follow-up were excluded. Fourteen cases underwent bilateral reconstruction, leading to a total of 132 ipsilateral breasts being analyzed.

2.3. Correction of malrotation

At our institution, the following three methods were applied to treat patients with implant malrotation: (1) manual reduction, (2) open reduction maintaining the previous implant, and (3) implant change to round type. Manual reduction was completed in the outpatient clinic. After reduction was conducted, further movement of the implant was checked with ultrasonography. The second method, surgical implant repositioning (Figure 2), involves a minimal surgical incision made in the operating room and repositioning of the implant. Adhesiolysis with capsulotomy and partial capsulectomy using breast endoscopy could be combined to prevent recurrence. This procedure was simple enough to complete under local anesthesia without admission. Massive irrigation was done and taping and garments were repeated strictly to prevent recurrence. The final method, implant change into the round type, aims to eliminate future malrotation issues (Figure 3). This procedure also could be completed successfully under both local and general anesthesia with or without capsulotomy.

2.4. Potential risk factors

Risk factors analyzed in this research are listed in Table 1. Patients were divided by mastectomy type as nipple-sparing mastectomy (NSM) or skin-sparing mastectomy (SSM). They were also categorized into two groups based on the surgical incision used: periareolar with lateral extension incision or inframammary fold incision. The existence of axillary lymph node dissection during mastectomy was also included. Reconstruction characteristics included the interval between tissue expander insertion and permanent implant insertion and the type of tissue expander used in the first stage from among two products: the style 133 V tissue expander with Biocell® texture (Allergan Medical Corporation, Santa Barbara, CA) and the CPX4 tissue expander with Siltex® surface (Mentor Worldwide LLC, Santa Barbara, CA), with the latter product boasting tails for the placement of sutures to prevent rotation. To represent overexpansion or pocket size, the ratio of expansion volume to implant volume was documented. Postoperative volume was not manually measured and was, thus, represented by the volume of the silicone implant used. Malrotation of the tissue expander was defined in the same manner. A deviation of more than 30 degrees was detected easily using a magnetic port location and confirmed in the second-stage operation. Capsular contracture of Baker's grade III/IV during the final follow-up was considered. All permanent implants used in this study were Mentor Contour Profile Gel Memorygel® (Mentor Worldwide LLC, Santa Barbara, CA) silicone anatomical implants.

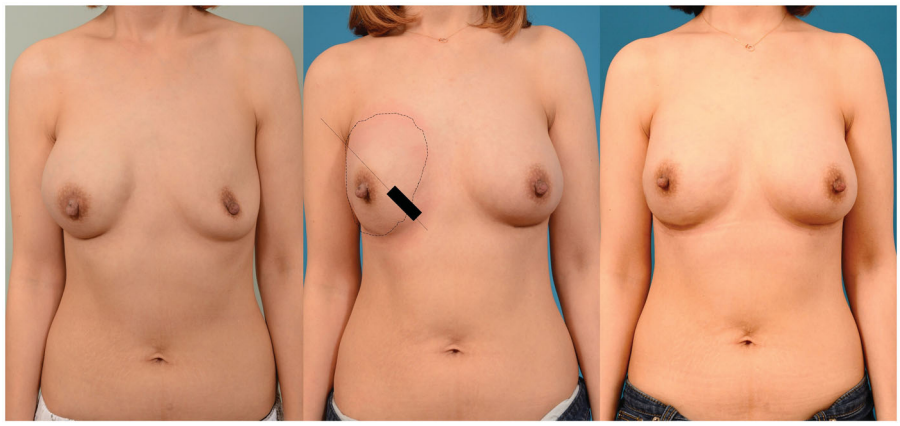

Figure 2. A 33-year-old female patient with right breast cancer experienced malrotation 4 months after second-stage reconstruction. Ultrasonography confirmed the positioning of the implant ridge at 4 o'clock. (*black bar*) Under local anesthesia, repositioning and capsulotomy were completed. Recurrence or complications such as infection or seroma (even without drainage) were not reported (*left*: Preoperative status, *middle*: 6 months after second-stage reconstruction, *right*: 1 year after repositioning of the anatomical implant).

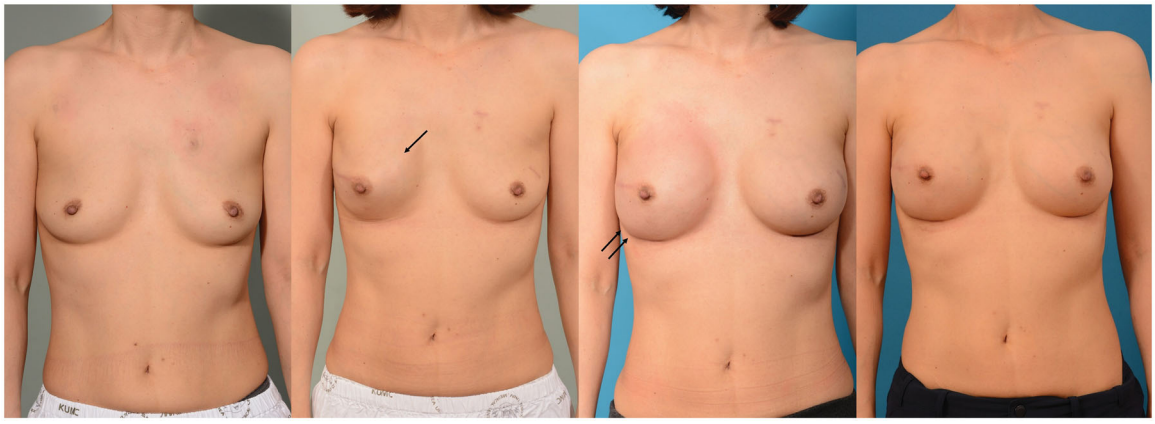

Figure 3. A 50-year-old female patient with right breast cancer showed malrotation at three months after second-stage reconstruction. Malrotation of the expander before the second stage was detected using a magnetic port (*black arrow*) and confirmed intraoperatively. Note that the implant ridge (*double black arrow*) was located on the same axis when malrotation occurred after the second-stage operation that included capsulectomy and surgical maneuvering to correct the pocket figure. Finally, she changed her implant to the round type. (*left*: preoperative status; *second to the left*: five months after first-stage tissue-expander insertion; *second from the right*: three months after second-stage reconstruction indicating malrotation; *right:* one year after implant change to the round type).

2.5. Statistics

Data analyses were performed using IBM SPSS® (IBM Corp., Armonk, NY). Demographic data of continuous variables were analyzed using a paired *t*-test and the Mann–Whitney *U* test with 95% confidence intervals. Categorical variables were analyzed using Pearson's chi-squared and Fischer's exact test. Variables for risk factors were coded as binomial. Age, BMI, and ratio variables were analyzed as continuous variables. Univariate analyses were conducted using a logistic regression model. Adjusted multivariate tests were completed using backward Wald logistic regression with $p < 0.20$ required for inclusion in the adjusted model. The chi-squared and Fischer's exact tests were applied to verify the independence of variables. Dependent variables were excluded in the reduced multivariate model.

3. Results

3.1. Demographics

A total of 17 (12.9%) cases among 132 breasts experienced malrotation. The demographic data of patients showing malrotation are summarized in Table 2. All patients with malrotation were receiving reconstruction due to breast cancer. The mean age of subjects included in this study was 48 years (range: 18–66 years) and body mass index values ranged from 17.45 to 39.68 kg/m^2 (mean value: 23.2 kg/m^2). There were 10 and 7 cases of right- and left-sided rotations, respectively. Eight and nine cases showed medial rotation and lateral rotation, respectively. There was no statistically significant difference in the side or direction of malrotation. It took a median 3.08 months from surgery to detect malrotation in the outpatient clinic (range: 1.13–5.03 months) (Table 3).

3.2. Risk factors for malrotation

The results of univariate and multivariate analyses are summarized in Table 4. Ten factors met the inclusion criteria for the adjusted multivariate model ($p < 0.20$).

Tissue expander malrotation in the first stage and capsular contracture were factors significantly associated with an increased risk of malrotation (odds ratios: 157.64 and 58.61, respectively).

3.3. Outcomes of revisional surgery

Among 17 patients with malrotation, all patients underwent manual reduction in the outpatient clinic. Among these, only two patients successfully achieved a manual reduction with

Table 1. Potential risk factors.

	Description
Patient demographics	
Age	Age at the time of second stage implant insertion
BMI	Body mass index
Preoperative volume	Preoperative breast volume (ml)
Hypertension	Patients with hypertension
Diabetes	Patients with diabetes
Smoking	Patients with smoking history
Follow-up period	Outpatient follow up after second stage implant insertion
Oncologic factors	
Hormone therapy	Patient who had hormone therapy after surgery
Radiation therapy	Patient who had radiation therapy after surgery
Adjuvant chemotherapy	
Neoadjuvant chemotherapy	
Mastectomy type	Nipple sparing mastectomy versus Skin sparing mastectomy
Axillary lymph node dissection	Patient who had additional lymph node dissection on Level I, II, III axillary lymph node
Reconstruction factors	
Interval between stages	Interval period between the first and second stage of breast reconstruction
Timing of Reconstruction	
Tissue expander device	
Ratio of expansion volume to implant volume	Volume ratio of expansion volume before second-stage surgery to the final implant volume
Ratio of preoperative breast volume to Implant volume	Volume ratio of initial breast volume before first stage surgery to the final implant volume
Postoperative volume	Represented by silicone implant volume used in reconstruction
Complication	
Malrotation of tissue expander	Malrotation of tissue expander detected before or during the second stage surgery (30 degree out of midline axis)
Capsular contracture	Capsular contracture of Baker's III, IV grade
Sustained seroma	Seroma detected and aspirated after 2 weeks of drain removal
Skin flap or nipple necrosis	Skin flap or nipple necrosis after mastectomy and the first stage of reconstruction
Surgical site infection	Clinical infection sign which required intravenous antibiotic treatment
Animation deformity	Visible movement of implant with pectoralis motion

Table 2. Demographics.

	Malrotation	Normal	*p* Value
Case	17 (12.9%)	115 (87.1%)	
Mean age	45.3 ± 7.7	48.7 ± 9.4	0.334
Median BMI	23.2 ± 5.12	22.2 ± 4.34	0.601
Median preoperative breast volume (ml)	250.0 ± 130.0	240.0 ± 140.0	0.794
Median follow-up period (month)	709.0 ± 340.0	772.0 ± 490.0	0.86
Reconstruction timing			
Immediate breast reconstruction	1 (5.8%)	7 (6.9%)	0.726
Delayed breast reconstruction	16 (94.2%)	108 (93.1%)	
Comorbidity			
Hypertension	3 (17.6%)	18 (15.7%)	0.533
Diabetes	1 (5.9%)	10 (8.7%)	0.572

confirmation of ultrasonography; however, both patients showed recurrent malrotation at a follow-up visit (Figures 3 and 4). Twelve patients (70.6%) underwent revisional surgery for malrotation correction, all of whom wanted to undergo revisional surgery due to aesthetic reasons. Additionally, nine patients had capsulectomy and underwent implant repositioning, while three patients changed their implants to the round type. Among the nine patients with capsulectomy subjected to implant repositioning, three experienced recurrent malrotation (Table 3).

4. Discussion

4.1. General

Anatomical silicone implants of asymmetric shapes offer the advantage of a favorable upper pole shape, especially in patients with breasts that are taller rather than wider [1,2,16–18]. Criteria for selection between round silicone gel and anatomical (or shaped) implants have remained under discussion. Some studies mentioned insignificant differences in rates of complications including malrotation [1–5]. Heden et al. [2,16] suggested that the choice of implant should take into account patients' desires, anatomy, and surgical history. Obviously, breast implant-associated anaplastic large-cell lymphoma has been a major consideration. Concerns about malrotation have been also responsible for some surgeons avoiding using anatomical implants.

In the current study, the total incidence of malrotation was 12.9%, which is higher relative to other rates reported in previous articles. Not many articles have analyzed cases of breast reconstruction. Caplin et al. [3] reported that rotation rates in primary augmentation and primary reconstruction are 1.5 and 5.8%, respectively. Among our study cohort, of 34 patients who underwent augmentation mammoplasty with contralateral balancing procedure, none had malrotation. This included five patients showing malrotation on one side who underwent a contralateral augmentation procedure without any malrotation. Although a larger study needs to be completed, our results support that rotation may occur more frequently in reconstruction cases. Precise manipulation of pocket dissection and expansion in two-stage breast reconstruction have been emphasized to prevent malrotation [2,7,16]. One explanation is that, as compared with augmentation mammoplasty, breast reconstruction deals with thinner mastectomy skin flaps as well as larger pockets and scars that may lead to a higher risk of malrotation [3].

Our study suggests that tissue expander malrotation at the first stage and capsular contracture were significant risk factors for malrotation. Many cases of malrotation in the present study were previously confirmed during the second stage operation intraoperatively as being, specifically, tissue expander malrotation in the first stage (Figure 3). Obviously, the same predisposing factors for malrotation are present in the same patient regardless of the stage of surgery. Also, sharing the implant pocket, which has a tendency to restore its distorted shape even after surgical correction, in the second stage takes place. Although two expander devices used in the study have different texture and only one of them has tails for suture placement, there was no siginificant difference of malrotation regardless of the tissue expander device.

Table 3. Profile of patients with confirmed malrotation.

Patient	Age at operation	Side	Direction	Follow-up period (m)	Time until malrotation detected (m)	Capsulectomy	Revision surgery	Outcome of revisional surgery
1	43	R	Counter clockwise	46.87	2.50	Partial capsulectomy	Capsulectomy and repositioning	Second malrotation
2	49	R	Clockwise	42.57	1.67	Partial capsulectomy	Capsulectomy and repositioning	
3	63	L	Clockwise	41.83	1.83	Partial capsulectomy	Capsulectomy and repositioning	Second malrotation Change to round implant
4	57	L	Clockwise	28.73	3.30	Partial capsulectomy	None	
5	46	R	Clockwise	27.87	5.03	Partial capsulectomy	Capsulectomy and repositioning	Second malrotation Change to round implant
6	45	L	Clockwise	26.70	4.93	Partial capsulectomy	Change to round implant	
7	43	L	Clockwise	38.93	2.20	Partial capsulectomy	Capsulectomy and repositioning	
8	47	R	Clockwise	25.77	2.60	Partial capsulectomy	Capsulectomy and repositioning	
9	39	R	Clockwise	25.23	3.00	Partial capsulectomy	None	
10	44	R	Clockwise	24.77	1.83	Partial capsulectomy	None	
11	49	L	Clockwise	24.07	3.47	Partial capsulectomy	Capsulectomy and repositioning	
12	36	R	Clockwise	23.60	4.17	Partial capsulectomy	none	
13	39	L	Clockwise	22.97	4.03	Partial capsulectomy	Capsulectomy and repositioning	
14	36	R	Counter clockwise	22.03	4.77	Partial capsulectomy	None	
15	52	L	Counter clockwise	20.50	0.00	Partial capsulectomy	Change to round implant	
16	33	R	Clockwise	17.53	3.93	Partial capsulectomy	Capsulectomy and repositioning	
17	49	R	Clockwise	16.67	1.97	Partial capsulectomy	Change to round implant	

L: left; R: right.

Table 4. Risk factor analysis of malrotation.

Factors	Mean value (± SD)	Number	Unadjusted OR	*p* Value	Adjusted OR	*p* Value
Demographics						
Age, years	48.23 ± 9.203		0.961 (0.908–1.016)	0.161	0.858 (0.729–1.011)	0.067
BMI, kg/m^2	23.21 ± 3.809		0.946 (0.812–1.103)	0.481		
Preoperative breast volume, ml	261.05 ± 131.84		0.999 (0.995–1.003)	0.505		
Hypertension		21 (15.9%)	1.155 (0.301–4.430)	0.834		
Diabetes		11 (8.3%)	0.656 (0.079–5.477)	0.697		
Smoking		5 (3.8%)	1.012 (0.883–1.161)	0.859		
Follow-up period, month	26.01 ± 7.95		0.999 (0.998–1.001)	0.565		
Oncologic factors						
Hormone therapy		104 (78.8%)	1.296 (0.345–4.869)	0.701		
Radiation therapy		19 (14.4%)	0.337 (0.042–2.701)	0.306		
Adjuvant chemotherapy		32 (24.2%)	0.956 (0.288–3.170)	0.941		
Neoadjuvant chemotherapy		5 (3.8%)	0.577 (0.061–5.487)	0.632		
Mastectomy type						
Skin sparing mastectomy		61 (46.2%)	2.772 (0.904–8.499)	0.074	1.532 (0.066-35.621)	0.282
Nipple sparing mastectomy		71 (53.8%)				
Incision						
Periareolar and lateral extension		85 (64.4%)	4.5 (0.980–20.661)	0.053	0.580 (0.008-42.222)	0.534
Inframammary fold incision		44 (33.3%)				
Axillary lymph node dissection		49 (37.1%)	2.109 (0.755–5.889)	0.154	2.618 (0.214-32.006)	0.843
Reconstruction factors						
Interval between stages	207.77 ± 100.649		1.000 (0.994–1.005)	0.876		
Delayed reconstruction		7 (5.3%)	1.135 (0.128–10.055)	0.909		
Tissue expander device						
Style 133 V expander®		85 (64.4%)	0.984 (0.339–2.857)	0.977		
CPX4 expander®		47 (35.6%)				
Ratio of expansion volume to implant volume	0.825 ± 0.260		0.148 (0.000–319.277)	0.626	0.148 (0.000-319.277)	0.692
Ratio of preoperative breast volume to Implant volume	0.865 ± 0.422		0.658 (0.187–2.319)	0.515		
Postoperative volume	314.43 ± 83.968		1.001 (0.995–1.007)	0.817		
Complication						
Malrotation of tissue expander		16 (12.1%)	121.333 (24.415–602.969)	<0.001	58.609 (5.738-598.646)	0.001*
Capsular contracture		18 (13.6%)	43.600 (11.553–164.544)	<0.001	157.638 (14.562-1706.460)	<0.001*
Sustained seroma		9 (6.8%)	20.364 (4.463–92.919)	<0.001	17.450 (0.688-442.881)	0.101
Skin flap or nipple necrosis		5 (3.8%)	4.978 (0.768–32.252)	0.092	31.610 (0.647-1545.442)	0.187
Surgical site infection		4 (3.0%)	1.412 (0.052–38.46)	0.838		
Animation deformity		5 (3.8%)	12.107 (1.860–78.822)	0.009	47.867 (0.715-3202.797)	0.58

BMI: body mass index; SD: standard deviation.

Tebbetts et al. [18] and Baeke et al. [8] noted that capsular contracture is related to malrotation. Theoretically, abnormal contracture of the pocket can distort the implant envelope, leading to malrotation. Panettiere et al. [13] found that excessive movement and external pressure such as compression of the pectoralis muscle can force the rotation of prosthetics, so these—together with use of an oversized pocket—are risk factors for malrotation. Recently, Montermurro et al. [7] reported that preoperative breast size is a predisposing factor of malrotation. On the other hand, preoperative breast volume or overexpansion indicating an expanded pocket size did not show statistical significance in our study.

Seroma might play a role as a lubricant to promote malrotation and reduce the resistance of an implant's surface, i.e. showing a 'Velcro effect' [19,20]. In our study, seroma showed a certain relevance in univariate analysis. However, it failed to display

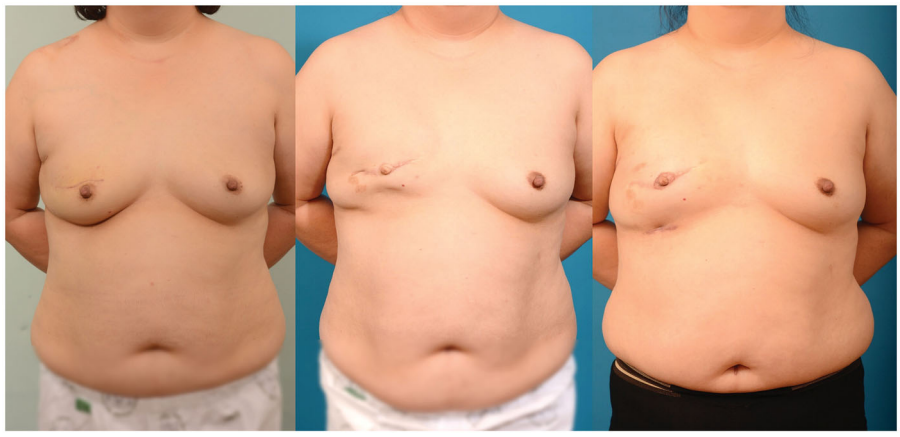

Figure 4. A 46-year-old female patient with right breast cancer presented malrotation at three months after second-stage reconstruction. She had a history of radiation therapy with the complication of nipple necrosis after mastectomy. The patient experienced recurrent malrotation after the first revisional surgery including partial capsulectomy. Finally, she changed her implant to the round type with capsulectomy using a new inframammary fold incision (*left*: preoperative status; *middle*, 1 year after second-stage reconstruction indicating malrotation; *right*: one year after implant change to the round type).

statistical significance in the multivariate analysis. There remains a need to distinguish reconstruction cases from augmentation mammoplasty due to their intrinsic characteristics.

Experts have implied that implant malrotation is highly related to technical error or limited surgeon experience [7]. However, our study argues that other factors are highly correlated with rotation. For example, surgical incision in the periareolar area and lateral extension (compared to other incision types) and skin-sparing mastectomy (compared to nipple-sparing mastectomy) presented certain correlation rates with malrotation, although they failed to show a statistical significance in multivariate analysis. Stevens et al. [21,22] stated that periareolar incisions could be a risk factor for capsular contracture and, in this study, both factors are highly related to capsular contracture and malrotation of expanders in the first stage (Pearson's chi-squared test, $p < 0.01$). Therefore, even though expander malrotation in the first stage and capsular contracture are the most relevant predictors, it is advisable for surgeons to remain aware that periareolar and lateral extension incisions and skin-sparing mastectomy could lead to an increased possibility of malrotation.

4.2. Correction of malrotation

Due to breast implant-associated anaplastic large-cell lymphoma, many institutes no longer use anatomical implants for breast reconstruction. However, following frequent use of anatomical implants in the past decade, many potential patients with malrotation are candidates for correction. All patients in this study with malrotation were tested for manual reduction. However, in cases where tissue adhesion has already taken place, the reduction of an implant is challenging and can recur. Therefore, in our experience, manual reduction in the office is not recommended. The second method, which includes making minimal surgical incisions in the operation room and repositioning the implant, could be done without changing the implant. However, we found that, in high-risk patients who have multiple risk factors, malrotation may repeatedly develop. Therefore, it is recommended for patients at higher risk of malrotation to undergo implant change to the round type in the first place.

4.3. Application of round implant type

Our clinic no longer uses anatomical implants or textured implants. However, from analyzing the cases of malrotation, we learned that the same degree of pocket distortion seen with these devices can be adopted for round implants, even though they do not appear to be so similar. Even so, there is a need to prevent distortion of the pocket or the application of a certain asymmetric force that can lead to malrotation. Adopting a primary prevention strategy involves the approach of preventing capsular contracture including deploying procedures such as irrigation, aseptic handling, and other methods previously described. However, from this study, we learned that it is important to avoid malrotation or distortion after tissue expander insertion. Therefore, it is crucial to position the tissue expander as secure as possible, and the location of the port for inflation using a magnetic navigator should be checked to monitor the malrotation of expander. If necessary, taping and garment can be applied to minimize the distortion of the implant pocket. If a patient shows the rotation of the expander in the first stage even after these attempts, it is recommended to conduct total capsulectomy and apply prolonged garment use with frequent check-ups thereafter.

4.4. Limitation

Our study design had a retrospective nature. Surgeon bias is another important issue. However, to minimize technical factors, we confined our study only to two-stage implant reconstruction. Even though our clinic uses various methods of implant reconstruction, including direct-to-implant method and implants with latissimus dorsi flap, we included only a single method to match technical differences. However, a larger number of patients is needed, including those receiving various types of anatomical implants. However, the use of a single type of implant may also be a strength of this study when considering confounding factors. Standardization of both a scale and techniques may be needed in the future for measuring malrotation. A sonographic approach should be applied to the whole study group for detection [15].

5. Conclusions

The results of a multivariate logistic regression model revealed that the malrotation of a tissue expander in the first stage and

capsular contracture were significant risk factors associated with malrotation in two-stage implant-based breast reconstruction (both $p < 0.001$). Revisional surgery for a rotated implant can be conducted with or without implant change; however, patients at higher risk should consider undergoing an implant change to the round type. Also, even when using a round implant in two-stage breast reconstruction, additional care should be adopted for those who showed rotation after expander insertion.

Disclosure statement

The authors have no financial interest to declare in relation to the content of this article.

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