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한승범 · 이동원 · 유대현

연세대학교 의과대학 성형외과학교실·인체조직복원연구소

Risk Factors of Tissue-Expander Infection in Breast Reconstruction

Sung Bum Han, M.D., Dong Won Lee, M.D.,
Dae Hyun Lew, M.D.

Institute for Human Tissue Restoration, Department of Plastic and Reconstructive Surgery, Yonsei University College of Medicine, Seoul, Korea

Purpose: Implant-based breast reconstruction has multiple advantages such as decreased morbidity, shorter operative time and faster recovery. However, postoperative infection with tissue expander increases medical cost and causes a delay in concurrent antineoplastic treatment. To reduce tissue expander infection, it is important to identify related risk factors and minimize them when possible.

Methods: A retrospective review of patient records in a single breast cancer center was performed. Eighty-six tissue expanders were placed in 80 women for postmastectomy breast reconstruction. Variables including patients'age, body mass index (BMI), preoperative breast volume, operation time, drain indwelling time, postoperative seroma/hematoma formation, chemotherapy, and radiation therapy were evaluated. Infection was defined as the status that shows any symptom of local inflammation and identification of pathogens. Representative values were compared through Student's t-test and univariate and multivariate analyses.

Results: We examined 86 postmastectomy tissue-expanders which were placed between June 2004 and April 2010. Seven cases of tissue expander infection (8.1%) were identified. The infected tissue expander was removed in three of the cases. The relationship between BMI, and preoperative breast volume and that between infection and non-infection groups were significant ($p<0.05$). Univariate analysis showed significant association between BMI ($p=0.023$) and preoperative breast volume ($p=0.037$). Multivariate analysis revealed that BMI and preoperative breast volume were independent variables regarding tissue expander infection.

Conclusion: Certain characteristics of implant-based breast reconstruction patients increase infection rate of tissue expander. These risk factors should be monitored and evaluated before surgeries for more successful outcome.

Key Words: Tissue expander, Infection, BMI, Breast volume, Breast reconstruction

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Address Correspondence : Dae Hyun Lew, M.D., Department of Plastic & Reconstructive Surgery, Yonsei University College of Medicine, 134 Sinchon-dong, Seodaemun-gu, 120-752 Seoul, Korea. Tel: 02) 2228-2219/Fax: 02) 393-6947/E-mail: dhlew@yuhs.ac

I. INTRODUCTION

A variety of reconstruction methods are currently available. Amongst them, autologous reconstruction is frequently recommended as it shows good postoperative patient satisfaction, aesthetically superb results, and greater endurance against antineoplstic therapy and postoperative infection. However, the donor site should be appropriately selected, and the patient's general condition should be considered, as the procedure might accompany donor-site morbidity and complications.

Meanwhile, implant-based breast reconstruction is preferred because of shorter operation time, lower donor morbidity, and faster recovery compared to autologous reconstruction, causing less physical and psychological burden. In addition, newly developed diagnostic tools and education for self-detection enable early diagnosis of breast cancer. In particular, younger breast cancer patients prefer methods that cause less donor-site disability and allow early recovery so that they can return to their daily lives. Implant-based breast reconstruction is in the spotlight as women are actively engaged in economic and social activities.[1]

While antibiotics and implants have been improved, operational-site infection remains the most significant problem. This incurs additional medical expenditures and affects subsequent antineoplastic treatment. Therefore, it is of great importance to identify the factors

behind the risk of infection associated with implant-based reconstruction surgery and to exercise caution when treating patients during and after surgery.[2]

Thus, we investigated and evaluated individual risk factors for tissue expander infection after mastectomy.

II. MATERIALS AND METHODS

We retrospectively reviewed records of 86 tissue expanders implanted in 80 patients following mastectomy at a single comprehensive breast cancer center between June 2004 and April 2010. Prior to conducting this study, the study was approved by the institutional review board, and all patients granted informed consent for this study. The patients' information and their medical histories were obtained through interviews during their out-patient visits. Potential risk factors, including age, body mass index (BMI), preoperative breast volume, operation time, postoperative seroma and hematoma formation, indwelling period of closed suction drain, and history of chemotherapy and radiation therapy were evaluated.

Each patient's height and weight were measured at admission to calculate BMI for operation. Operation time was recorded from the start of reconstruction by the plastic team to skin closure. All the other parameters were collected from electronic medical records. All operations were limited to the immediate reconstruction following total mastectomy by a single breast oncologic surgeon and reconstructive surgeon of the center.

Dissection of lymph nodes was planned in accordance with preoperative staging work-up such as breast ultrasonography and MRI, and was decided based on the tumor cells on the surgical margin, sentinel lymph node and pathologic biopsy results. Tissue expanders were placed after mastectomy, and their sizes were decided based on the preoperative breast volume or the contralateral breast volume. Augmentation or reduction of the normal breast was considered and planned upon patients' request. In operations, the tissue expanders were fully covered by the pectoralis major and serratus anterior. Prophylactic antibiotics were administered for all patients after operations. Tissue expansion was carried out using sterile injectable saline from 18 days after surgery depending on the patient's progress. The goals for tissue expansion were reached a minimum of one month and a maximum of 12 months after initiating the expansion. Expansion was discontinued when patients' complained of discomfort or scheduled for concurrent antineoplastic treatment.

In this study, infection was defined as operational site erythema, local heating, complaints of tenderness, purulent discharge from the operational wound site and other clinical signs as well as pathogens identified in patients'discharge. Elevated body temperature which was either relieved or subsided after oral or intravenous administration of antibiotics was also considered infection.

To establish the risk factors of postoperative tissue expander infection, patients without infection (non-infection group) and with infection (infection group) were compared, and the correlation between risk factors and tissue expander infection was investigated. A Student's *t*-test and *chi*-square test were used to compare the average values of the parameters between two groups, and the correlation between risk factors and infection after surgery was examined using univariate logistic regression. Multivariate logistic regression was employed to calculate the odds ratio and the contribution of the risk factors that showed significant correlation in univariate logistic regression analysis. In all statistical analyses, values with p less than 0.05 were considered significant.

III. RESULTS

A total of 86 tissue expanders of 80 patients, including six patients with bilateral tissue expander insertion, were analyzed. Tissue expander infection was identified in 7 cases (8.1%). Three of them were reported during the expansion period. In 4 cases, infection was cured through conservative management with antibiotics and non-steroidal anti-inflammatory drugs. In the other 3 cases, tissue expanders had to be removed.

The mean age of the patients was 42.5 years old. The average age of the non-infection group was 40.2 years and the infection group 47.1 years. The average BMI of the non-infection group was 21.4 kg/m^2 and the infection group 23.8 kg/m^2. The average preoperative breast volume was 299 cc for the non-infection group and 401 cc for the infection-group. As such, the BMI and breast volume showed significant differences between the two groups ($p < 0.05$). The average operation time of non-infection group was 2 hours and 23 minutes and infection group was 2 hours and 27 minutes, showing no significant difference. The rate of immediate postoperative seroma formation was 19% for the non-infection group and 42.9% for the infection group ($p > 0.05$). Hematoma was formed in 2.5% of the non-infection group patients and 25% of the infection group patients

Table I. Risk Factors of Tissue Expander Infection

	Non-infection group (n=79)	Infection group (n=7)	*p*
Age (year)	40.2	47.2	0.120
Breast vol. (cc)	299	401	0.025*
BMI (kg/m^2)	21.4	23.8	0.008*
Op. time (min)	143	147	0.393
Drain indwelling (days)	14.5	17	0.156
Seroma	19.0%	42.9%	0.203
Hematoma	2.5%	25%	0.105
CTx.	38.0%	28.6%	0.703
RTx.	7.6%	0%	0.884

Values for "Age", "Breast vol.", "BMI", "Op. time", "Drain indwelling" are mean values.
Values for "Seroma", "Hematoma", "CTx.", "RTx." are percentage of patients with experience.
*$p<0.05$.

($p>0.05$). A closed suction drain was placed in all patients after operation, and the drain was kept inserted for a mean period of 14.5 days for the non-infection group and 17 days for the infection group. Chemotherapy was provided to 31 patients: 29 from the non-infection group and 2 from the infection group. Radiation therapy was given to only 6 non-infection patients (Table I).

In univariate logistic regression analysis, postoperative tissue expander infection was correlated with BMI ($p=0.023$) and with preoperative breast volume ($p=0.037$). Thus, BMI and preoperative breast volume were analyzed in the multivariate model, and the analysis identified BMI as an independent risk factor for tissue expander infection after surgery. Infection incidents rose by 1.47 times for each one kilogram per m^2 of body mass ($p=0.018$). Infection incidents doubled for every 100 cc of preoperative breast volume, which was not significant ($p=0.065$) (Tables II, III).

Wound culture was conducted using specimens taken from discharge collected from five infection cases. Pathogens were identified as methicillin-resistant *S. aureus* in three cases, methicillin-sensitive *S. aureus* in one, and diphtheroid in the other one. The three cases with methicillin-resistant *S. aureus* were treated with intravenous injection of vancomycin followed by surgical drainage, tissue expanders had to be surgically removed in all three cases.

IV. DISCUSSION

In our study, infection was observed in 7 cases (8.1%) of the study population, which falls within the 3.5% to 24% infection range reported in previous studies.[2-4] The previous studies had different sizes of populations, and their infection rates varied depending on the definition of infection. This study used a broad definition of infection, including cases where pathogens were confirmed through wound culture and all clinical signs such as fever, complaint of pain at the surgical site, and visible erythema. However, discomfort and pain expressed by patients during the expansion process as well as fevers related to chemotherapy were excluded from infection criteria. Also excluded were the cases where only normal flora of skin was confirmed by wound culture with no clinical symptoms. The 3 infection cases identified during expansion may be cases of retrograde infection via drain tube or percutaneous infection through saline injection procedure. Another possibility is that subclinical infection of expander which was contaminated at the time of operation was exaggerated during expansion phase. Since this is a retrospective study, the exact cause of infections could not be explained, which is a limitation of this study.

Considering the mean age of all patients, the mean age of the infection group was relatively higher than the non-infection group. However, there was no clear correlation between tissue expander infection and age. McCarthy and Pusic presented patient age as a possible risk factor for complications after breast reconstruction surgery. In their study with 153 patients, Antony and Disa reported an increase in incidents of complications after breast reconstruction operations in older patients.[2,5] Nevertheless, Walton and Audisio found no clear correlation between infection and age,[6,7] and the same con-

Table II. Univariate Analysis of Infection Risk Factor

Factor	Total number	Infection case	*p*
Age (years)			0.117
≤ 55	77	5	
55 <	9	2	
Breast volume (cc)			0.037*
≤ 450	75	4	
450 <	11	3	
BMI (kg/m^2)			0.023*
≤ 24	68	4	
24 <	18	3	
Operation time (min)			0.083
≤ 210	71	6	
210 <	15	1	
Drain maintain (days)			0.358
≤ 15	53	3	
15 <	32	4	
Seroma			0.409
Yes	18	3	
No	68	4	
Hematoma			0.118
Yes	4	2	
No	82	5	
CTx.			0.357
Yes	32	2	
No	54	5	
RTx.			0.999
Yes	6	0	
No	80	7	

*p < 0.05

Table III. Multivariate Analysis and Odds Ratio of Tissue Expander Infection Risk Factors

	Odds ratio	*p*
BMI	1.47 per 1 unit increase	0.018*
Breast volume	2.00 per 100 cc increase	0.065

*p < 0.05

clusion was reached in this study.

BMIs of the non-infection and infection groups were significantly different. The univariate logistic regression analysis also confirmed a significant correlation between tissue expander infection and BMI. A number of previous studies also pointed out patients' BMI as a risk factor for postoperative complications. McCarthy and Pusic examined 1,170 implant-based breast reconstructions and found a high correlation between BMI and postoperative infection and other complications. This correlation can be explained in several ways. First, larger dissection boundaries in obese patients mean greater exposure to the external environment and subsequently more pathogens. In addition, large skin flaps is associated with

a higher rate of partial necrosis of mastectomy flaps, causing higher chance of implants to infection. Obese patients also tend to have poor general health conditions and lower immunity, which could increase complications after surgery.[2,5,8]

The correlation between preoperative breast volume and infection was confirmed through univariate logistic regression. This means that the bigger the preoperative breast volume is, the greater the operational site and the size of mastectomy flap are. This seems to contribute to the increase contact surface with the expander and the dead space, predisposing to infections. The same result was obtained in other studies which examined the correlations between complications, the weight of excised breast tissue, and that of brassieres.[9,10] However, in our study, we found no significant difference in the operation time between the two groups. While breast size tended to increase along with BMI, we separately analyzed the correlation between infection and breast size and that between infection and BMI.

After inserting the implant, the infection group experienced a greater degree of postoperative seroma and hematoma formation. Seroma and hematoma formed at the operational site serve as a medium for microorganisms, leading to implant infection. Generally, a closed suction drain is considered to prevent seroma and hematoma formation. Nevertheless, in their cohort study involving 1863 patients, McCarthy and Cordeiro concluded that a closed suction drain did not prevent formation of seroma and hematoma and complications at surgical sites.[11] In our study, we did not identify any correlation between infection and an indwelling period of the closed suction drain indwelling. Further study is warranted to investigate whether placement of a closed suction drain causes infection or whether a surgical site infection prolongs the drain indwelling period.

The five cases of infection with purulent discharge were identified during the outpatient follow up period. Three of them where infection was caused by methicillin-resistant *S. aureus* were treated by intravenous administration of vancomycin and salvage procedures of surgical drainage, capsulectomy and tissue expander irrigation. However, the implant had to be removed in all three cases as infections persisted. In the other two cases, no more signs of infection were observed after one week of conservative treatment, including antibiotics therapy, and tissue expansion was conducted as planned. A 15-year study by Spear et al. also indicates a low success rate of the salvage procedure in cases where atypical pathogens, including methicillin-resistant *S. aureus*. They used wound culture results as a basis for the decision of whether the salvage procedure should be performed or not.[12]

In our study, the infection and non-infection groups exhibited no significant discrepancy in chemotherapy and radiation therapy. Previous studies reported that radiation treatment increases the rate of complication such as infection and exposure of implants.[9,13] At our center, breast reconstruction is performed primarily in patients at clinical stage II or earlier stages, most of whom do not need chemotherapy. In addition, our breast cancer treatment team employs chemotherapy rather than radiation therapy for patients requiring antineoplastic treatment. As a result, the number of patients treated with radiation therapy was insufficient to compare their results with those treated with chemotherapy.

V. CONCLUSION

In this study, BMI and preoperative breast volume showed a significant correlation with postoperative infection. For obese patients or patients with large breasts, breast reconstruction methods should be carefully selected, and close attention and special care are required for postoperative wound management and prevention of implant infection.

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