Original Article

Current status of breast reconstruction in China: an experience of 951 breast reconstructions from a single institute

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Background: Since mastectomy remained the primary strategy for treating breast cancer in China, post-mastectomy reconstruction is of great importance in the Chinese population. The current study aimed to assess the current status of breast reconstruction in China.

Methods: We reviewed all patients who received breast reconstruction from August 2000 to July 2015 in the Department of Breast Surgery in our institute. Patients' baseline characteristics, reconstruction strategy, final pathology and loco-regional recurrence (LRR) information were collected.

Results: A total of 951 breast reconstructions were conducted during the past 15 years, among which 247 (27.0%) were abdominal flap reconstruction; 471 (51.5%) were latissimus dorsi myocutaneous ± implant; and 233 (25.5%) were prosthesis-based reconstruction. The majority of cases (78.1%) were invasive breast cancer and up to 894 cases (94.0%) were immediate reconstruction. Prosthesis-based reconstruction rapidly increased in recent years, and was associated with bilateral reconstruction, contralateral augmentation and higher complications. 18 patients (2.0%) developed local-regional recurrence at the median follow-up time of 26.6 months (range, 3.7–62.0 months). A total of 66 nipple-areolar complex-sparing mastectomies (NSMs) (6.9%) were performed, none of which developed recurrence.

Conclusions: Breast reconstruction cases increased over the 15 years with the change of paradigm. Most strikingly, prosthesis-based reconstruction rapidly gained its prevalence and became the most common strategy. NSM was only performed for highly selected patients. Patients with breast reconstruction were able to achieve satisfactory loco-regional control in our cohort.

Keywords: Breast reconstruction; breast cancer; China; current status

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Introduction

With the improvement of systemic treatment, the surgical management of breast cancer experienced substantial revolution over the years. Although breast-conserving therapy (BCT) has become the primary surgical treatment for breast cancer worldwide, and approximately 60–70% of stage 0–II patients in the United States undergo BCT (1), a multi-center retrospective study in China indicated that modified radical mastectomy remained the primary strategy for treating breast cancer (2).

Thus, post-mastectomy reconstruction is of great

importance in the Chinese population. In recent years, attentions have been focused on this field, which would significantly improve aesthetic outcome for breast cancer patients on the basis of not affecting the oncological results. Multiple mastectomy techniques, such as skin-sparing mastectomy (SSM) and nipple-areolar complex-sparing mastectomy (NSM), combined with immediate breast reconstruction, were adopted for patients with reconstruction demand. Also, various techniques were performed for reconstruction, including pedicle transverse rectus abdominis myocutaneous (TRAM) flap reconstruction, free-TRAM flap reconstruction, latissimus dorsi myocutaneous flap (LDMF) reconstruction and prosthesis-based reconstruction.

The current study aimed to assess the current status of breast reconstruction in China, by reviewing 951 breast reconstruction cases over the past 15 years in Fudan University Shanghai Cancer Center (FUSCC). We also described the paradigm change and local-regional control of these patients.

Materials and methods

Patients

We reviewed all patients who received breast reconstruction from August 2000 to July 2015 in the Department of Breast Surgery FUSCC. The following inclusion criteria were applied: (I) female patients who received reconstruction after mastectomy; (II) therapeutic and prophylactic cases; (III) unilateral and bilateral patients with breast reconstruction; (IV) immediate and delayed reconstruction. However, patients with breast-conserving surgery and partial reconstruction were excluded. Patients' baseline characteristics, reconstruction strategy, final pathology and loco-regional recurrence (LRR) information were collected. The 7th edition of the AJCC TNM was utilized to stage the patients. The protocol for the present study was approved by the Ethics Committee of FUSCC.

Reconstruction methods

The surgical management of the patients was grouped as follows: LDMF flap reconstruction (including extended LDMF flap reconstruction and LDMF + implant reconstruction), abdominal flap reconstruction (pedicle-TRAM and free-TRAM reconstruction), and prosthesis-based reconstruction (direct to implant reconstruction and two-stage reconstruction). In the two-stage prosthesis-based reconstruction, patients were implanted with a soft-tissue expander immediately after mastectomy. After inflating the expander with saline over a period of time, the expander is then replaced with a permanent implant. Nipple reconstruction, return to operation room (OR) complications, contralateral breast aesthetic surgeries, and ipsilateral breast modification were also included into analysis.

Follow-up

The follow-up data on the breast cancer patients were acquired from the Department of Clinical Statistics of FUSCC. LRR was defined as any progression in the ipsilateral breast, skin, muscles of the chest wall and/or axillary/supraclavicular lymph nodes (LNs). Survival was calculated from the date of surgery to the date of clinical relapse. Patients whose last follow-up was ≤3 months after surgery were regarded as lost to follow-up and were excluded from analysis.

Results

Baseline characteristics of patients

From August 2000 to July 2015, a total of 951 breast reconstructions were conducted in our institute. Among these cases, 885 patients had unilateral breast reconstruction; 31 patients had bilateral breast reconstruction; one patient had bilateral reconstruction while received a third reconstruction after flap loss of her right breast. The median age of patients to have breast reconstruction was 39 years old (range, 19–77 years old). In 31 bilateral reconstruction patients, 23 suffered from bilateral breast cancer, and 8 had unilateral breast cancer and contralateral prophylactic mastectomy.

The clinical pathological characteristics of patients' primary breast disease were demonstrated in *Table 1*. The majority of cases (78.1%) were invasive breast cancer and breast cancer *in situ* (17.1%). The median size for invasive breast cancer was 2.2 cm (IQR: 1.5–3.0 cm), for breast cancer *in situ* was 2.0 cm (IQR: 1.2–2.5 cm) and for other breast tumor was 4.5 cm (IQR: 2.5–5.6 cm), respectively. Of all patients, 26 had previous breast-conserving surgery and developed ipsilateral breast recurrence. They subsequently had mastectomy and breast reconstruction; 39 cases received neo-adjuvant chemotherapy prior to surgery

and reconstruction, seven of which achieved pathological complete remission (pCR).

Current status and trend of breast reconstruction in FUSCC

In 915 cases, 247 (27.0%) were abdominal flap reconstruction; 471 (51.5%) were LDMF ± implant reconstruction; and 233 (25.5%) were prosthesis-based reconstruction, among which 188 were expander-implant reconstruction and 45 were direct-to-implant reconstruction. In terms of timing, 894 cases (94.0%) were immediate reconstruction; 51 cases (5.4%) were delayed reconstruction; and six cases were delayed-immediate reconstruction.

The trend of breast reconstruction by year was illustrated in *Table 2* and *Figure 1*. There was a significant change in breast reconstruction strategy over the years. Notably, although the total breast reconstruction cases increased steadily, the percentile of reconstruction strategies varied. LDMF ± implant (*Figure 2*) had remained most common method until 2014, while prosthesis-based reconstruction rose rapidly from eight cases in 2012 to 106 cases in 2015, increased more than 10-fold during this short period (*Figure 3*). Pedicle-TRAM reconstruction was gradually replaced by free-TRAM reconstruction since 2011 (*Figure 4*). Nevertheless, free abdominal flap reconstruction decreased gently in recent years.

Among all reconstructions, 20 cases failed to complete reconstruction, including total flap loss in three cases of free TRAM reconstruction, 16 cases of expander or implant loss in prosthesis-based reconstruction, and one case in LDMF + implant reconstruction due to implant exposure. Most interestingly, 13 out of 16 (81.2%) cases in the prosthesis-based group lost their expander/implant without specific complications, except for patients regretting their decision to receive reconstruction. Two patients lost their expander/

Table 1 Baseline clinical-pathological characteristics of patients' primary breast disease according to final pathology

Pathology	N (%)
Invasive breast cancer	743 (78.1)
Stage 0–I[†]	277 (37.3)
Stage II	275 (37.0)
Stage III	79 (10.6)
In situ breast cancer	163 (17.1)
Ductal carcinoma *in situ*	156 (95.7)
Lobular carcinoma *in situ*	7 (4.3)
Phyllodes tumor	28 (2.9)
Other malignant breast tumor	7 (0.7)
Prophylactic mastectomy	8 (0.8)
Unknown	3 (0.3)

[†], seven patients received neo-adjuvant achieved pathological complete remission and staged 0.

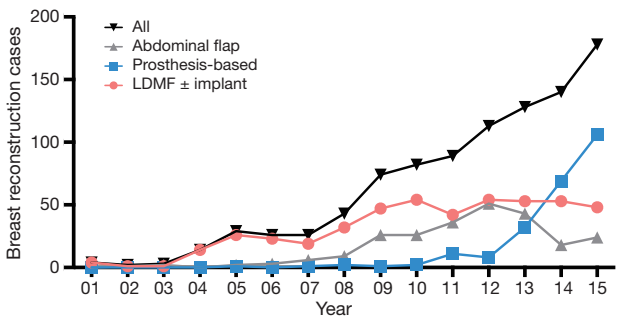

Figure 1 Trend of breast reconstruction in FUSCC. FUSCC, Fudan University Shanghai Cancer Center.

Table 2 Breast reconstruction trends in different surgical groups

Year[†]	2000–2001	2001–2002	2002–2003	2003–2004	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015	Total
LDMF ± implant, N (%)	4 (100.0)	1 (50.0)	1 (33.3)	14 (100.0)	26 (89.7)	23 (88.5)	19 (73.1)	32 (74.4)	47 (63.5)	54 (65.9)	42 (47.2)	54 (47.8)	53 (41.4)	53 (37.9)	48 (27.0)	471 (49.5)
Prosthesis-based, N (%)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.4)	0 (0.0)	1 (3.8)	2 (4.7)	1 (1.4)	2 (2.4)	11 (12.4)	8 (7.1)	32 (25.0)	69 (49.3)	106 (59.6)	233 (24.5)
Pedicle-TRAM, N (%)	0 (0.0)	1 (50.0)	2 (66.7)	0 (0.0)	2 (6.9)	3 (11.5)	2 (7.7)	7 (16.3)	23 (31.1)	23 (28.0)	7 (7.9)	7 (6.2)	10 (7.8)	4 (2.9)	0 (0.0)	91 (9.6)
Free-TRAM, N (%)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (15.4)	2 (4.7)	3 (4.1)	3 (3.7)	29 (32.6)	44 (38.9)	33 (25.8)	14 (10.0)	24 (13.5)	156 (16.4)
Total	4	2	3	14	29	26	26	43	74	82	89	113	128	140	178	951

[†], time interval was calculated from August of the prior year to July of the next year.

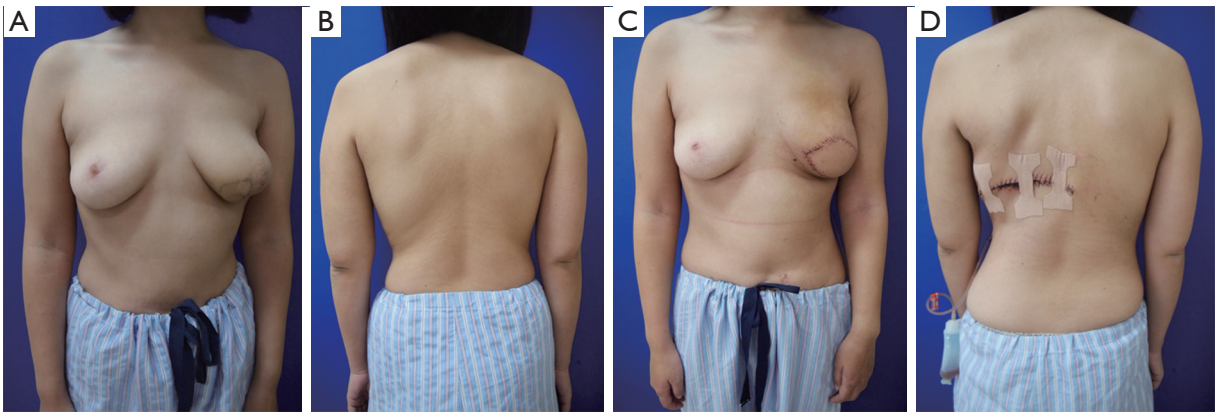

Figure 2 LDMF flap breast reconstruction. (A,B) Pre-operative pictures; (C,D) postoperative pictures with reconstructed breast and donor site scar. LDMF, latissimus dorsi myocutaneous flap.

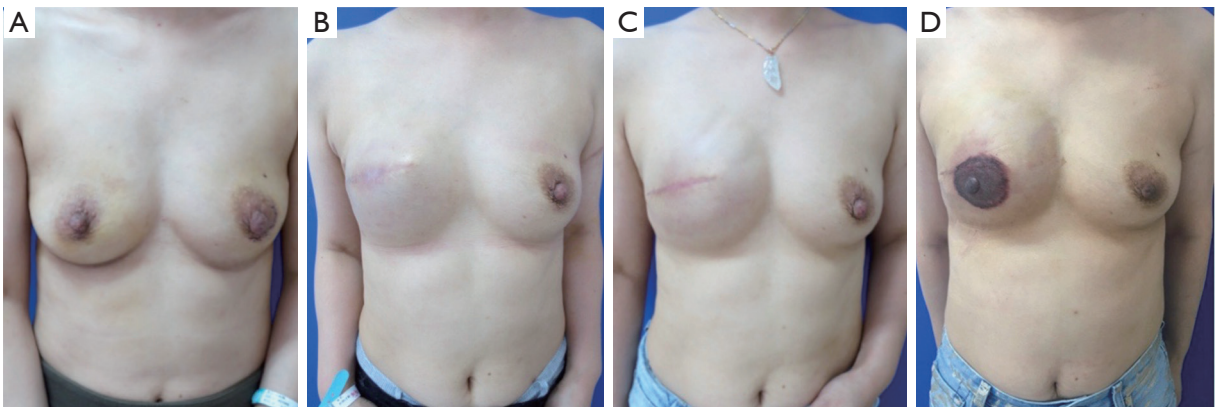

Figure 3 Expander-implant two stage breast reconstructions. (A) Pre-operative pictures; (B) after skin-sparing mastectomy and immediate expander reconstruction, the patient's expander was injected with saline bi-weekly with satisfied appearance; (C) the patient's expander was replaced by permanent implant; (D) the patient received nipple reconstruction and tattoo of nipple-areolar complex (NAC).

implant because of post-operative infection; and one patient required her implant removal due to discomfort. Moreover, three patients (two unilateral cases and one bilateral case) failed to turn up in our institute for permanent implant placement after expander reconstruction for more than 2 years, indicating they probably did not complete the two-stage reconstructive surgery.

Thirty-eight cases (4.0%) developed post-operative complications that required re-operation. In prosthesis-based reconstruction, 15 cases returned to operation room with varied reasons, such as infection, expander rupture and expander/implant exposure. Prosthesis-based reconstruction also had more contralateral breast surgery than other reconstructive surgeries, the majority of which were contralateral breast reconstruction (15.9%) and contralateral breast augmentation (9.9%). In the meantime, abdominal flap group had the most contralateral breast reduction/mastopexy cases (4.9%) (*Figure 5*). Abdominal flap reconstruction also had the most percentiles of ipsilateral breast modification (5.7%) and nipple reconstruction (24.7%) among three reconstruction surgeries (*Table 3*).

NSM in breast reconstruction

For reconstructive patients, we routinely performed SSM. A total of 66 NSMs (6.9%) were performed in 61 patients, 11 of which in LDM ± implant group and 55 in prosthesis-based group. The breast diseases for these cases were as follows: 34 (61.8%) were invasive breast cancer; 14 (25.4%) were *in situ* breast cancer; 12 (21.8%) were phyllodes

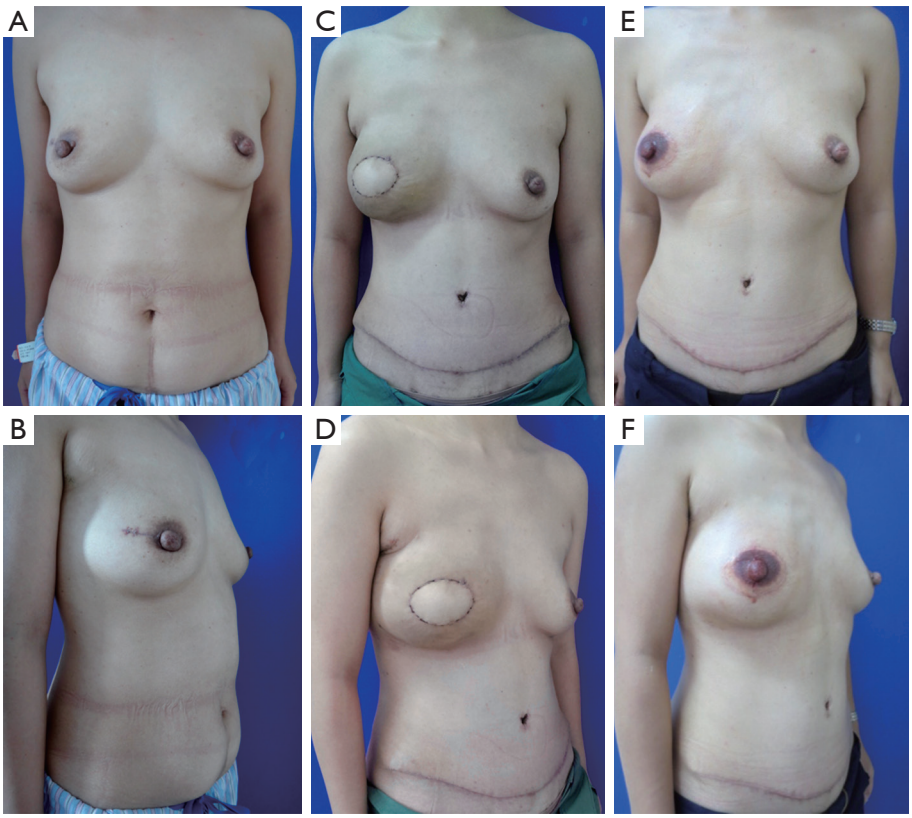

Figure 4 Muscle-sparing free TRAM flap reconstruction. (A,B) Pre-operative pictures; (C,D) 3 months after skin-sparing mastectomy and immediate reconstructive surgery; (E,F) 1 year after initial breast reconstruction followed by second-stage nipple reconstruction and tattoo of nipple-areolar complex (NAC).

tumor; five for prophylactic mastectomy; and one for other malignant breast tumor. One case received intra-operative single-dose nipple-areola complex (NAC) radiotherapy; in another case, the patient required to resect the NAC because of concerns of NAC recurrence. None of the patients developed NAC, other loco-regional or distant recurrence in our cohort.

Loco-regional control of breast cancer patients with reconstruction

A total of 887 cases were more than three months. The median follow-up time was 28.2 months (range, 3.0–159.1 months). Eighteen patients (2.0%) developed local-regional recurrence at the median follow-up time of 26.6 months (range, 3.7–62.0 months). Eight patients developed distant metastasis prior to or at the same time of local-regional recurrence. Two patients developed local-regional recurrence prior to distant metastasis and seven patients developed local-regional recurrence only (*Table 4*). In terms of the site of local-regional recurrence, 9 out of 18 patients developed breast/chest wall recurrence, four patients had supra-clavicle LN recurrence, two had axillary LN recurrence, two had internal mammary LN recurrence and one patient was not documented the specific site of recurrence. None of these patients died in our cohort.

Discussion

The current study revealed a significant trend of increase in breast reconstruction cases in FUSCC. However, compared with the great amount of mastectomies performed in China, breast reconstruction stays at a rather stable low rate of 3.5–4.5% over the past 15 years (3,4). Several reasons were thought to contribute to the low rate of reconstruction in China. Firstly, traditional Chinese women have low demand for their body image, and many of them are unaware of the possibility of breast reconstruction, especially for the older

generations, which explained why the median age for breast reconstruction was 39 years old while the median age for breast surgery was around 50 in our institute (5). Secondly, the heavy workload hampered the generalized application of reconstruction techniques. As reported by previous studies, there was a 4-fold increase of breast surgeries between 2006 and 2014 while the number of breast surgeons increased from 13 to 15 in FUSCC (3). Next, the dramatic increase of prophylactic mastectomy in Western countries increased reconstruction rate (6,7), while in China, this has little impact since such procedures are rarely performed. Lastly, limited patient education resulted that some patients were not aware of the option of breast reconstruction.

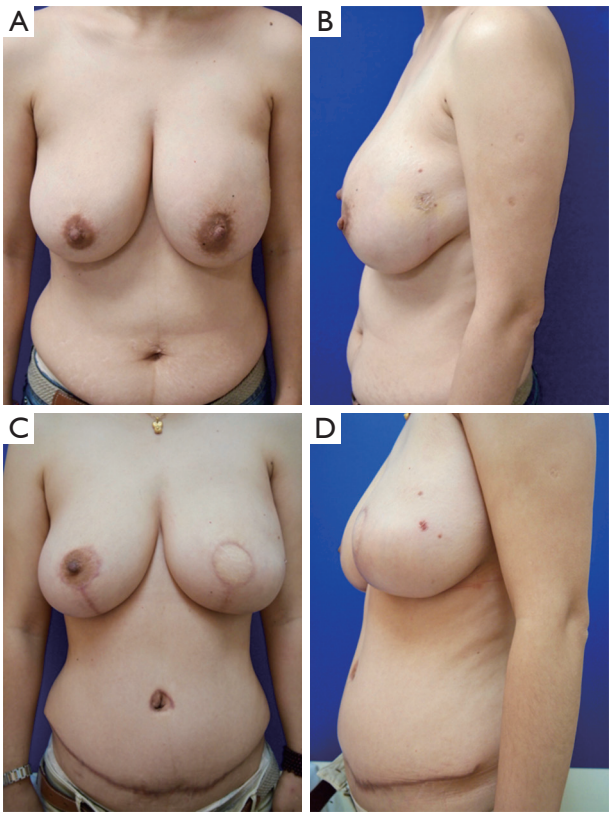

Figure 5 Free abdominal flap reconstruction with immediate contralateral breast reduction. (A,B) Pre-operative pictures; (C,D) postoperative pictures.

Significant shift in breast reconstruction paradigm was observed in our cohort. Prosthesis-based reconstruction displayed a more than ten-fold increase from 2012 to 2015, which echo with the worldwide transformation. In US, prosthesis-based reconstruction rates increased on average 11% per year from 8.52% in 1998 to 25.8% in 2008, surpassing autologous reconstruction to be the leading reconstructive method (8). The use of prosthesis can achieve aesthetical symmetrical appearance in bilateral reconstruction patients, especially in slim women whose autologous tissue may not be abundant enough for reconstruction. In our cohort, up to 15.9% patients had bilateral reconstruction in the prosthesis-based reconstruction group, much higher than other modalities; and another 9.9% patients had contralateral breast augmentation. In sum, up to 25% patients had bilateral implants placed. Notably, despite the advantages of short operation time and in-hospital time, prosthesis-based reconstruction had the highest fail-to-complete-reconstruction rate and return-to-operation room rate. Most surprisingly, the majority of patients had their implant/expander removed because that they regretted their decision to have prosthesis-based reconstruction. Further investigations are awaited to explore the reason behind this phenomenon.

For autologous reconstruction, on the other hand, our data suggested that pedicle-TRAM reconstruction

Table 3 Comparisons of other surgical conditions besides reconstruction in different surgical groups

Surgical conditions	Total, N=951 (%)	Abdominal flap, N=247 (%)	LDM ± implant, N=471 (%)	Prosthesis-based, N=233 (%)
Fail to complete surgery	20 (2.1)	3 (1.2)	1 (0.2)	16 (6.9)
Return to OR complications	38 (4.0)	13 (5.3)	10 (2.1)	15 (6.4)
Contralateral breast surgery†	108 (11.4)	21 (8.5)	18 (3.8)	69 (29.6)
Reconstruction	53 (5.6)	7 (2.8)	9 (1.9)	37 (15.9)
Reduction/mastopexy	44 (4.6)	12 (4.9)	9 (1.9)	9 (3.9)
Augmentation	11 (1.2)	2 (0.8)	0 (0.0)	23 (9.9)
Ipsilateral breast modification	19 (2.0)	14 (5.7)	2 (0.4)	3 (1.3)
Nipple reconstruction	102 (10.7)	61 (24.7)	34 (7.2)	7 (3.0)

†, biopsy and breast-conserving surgery and mastectomy of the contralateral breast were excluded. OR, operation room.

Table 4 Characteristics of breast reconstruction patients who developed LRR prior to distant metastasis or LRR only

No.	Age	Reconstruction	Pathology	Stage	LRR time (mo)	LRR site	Status (mo)
1	30	LDMF	IDC	IIB	37.5	Chest	DRFS 117.1
2	54	LDMF + implant	IDC	pCR	37.6	Chest	Bone m at 56.6
3	50	Pedicled TRAM	IDC	IIB	24.2	Chest	DRFS 84.9
4	42	Free TRAM	IDC	IIA	6.9	Supra-clavicle LN	DRFS 18.3
5	40	LDMF	IDC	IIB	50.6	Axillary LN	DRFS 68.5
6	34	Free TRAM	DCIS + micro invasion	IIA	19.6	Chest	DRFS 36.2
7	36	LDMF + implant	DCIS + micro invasion	IA	36.2	Chest	DRFS 49.1
8	44	Free TRAM	IDC	IIA	8.0	Internal mammary LN	Lung m at 29.2
9	35	LDMF + implant	DCIS + micro invasion	IIA	28.9	Chest	DRFS 34.7
10	27	Prosthesis-based	IDC	IIA	12.5	IMLN	DRFS 26.6

LRR, loco-regional recurrence; LDMF, latissimus dorsi myocutaneous flap; IDC, invasive ductal carcinoma; pCR, pathological complete remission; m, metastasis; DRFS, distant recurrence-free survival; TRAM, transverse rectus abdominis myocutaneous; DCIS, ductal carcinoma *in situ*; LN, lymph node; met, metastasis; mo, months.

was gradually replaced by free-TRAM reconstruction since 2011. Compared with pedicle-TRAM, free-TRAM has significantly lower rate of the complication including abdominal bulge, abdominal strength weaken and hernia, with improved blood supply (9,10). Despite all the advantages, the application of free-TRAM was largely restricted by professional microsurgery skills and techniques as well as a much longer learning curve (11). As a typical cancer center in mainland China, there is no Department of Plastics and Reconstructive Surgery in FUCSS and all free-TRAM cases were performed by one single surgeon, which explained why LDMF reconstruction remained the most common method of autologous reconstruction. Furthermore, patients with abdominal flap reconstruction were more likely to have ipilateral breast modification surgeries and nipple reconstruction than other reconstruction modalities, which implied these patients might have a higher demand for breast symmetry and self-image.

Although SSM is routinely performed for patients who received breast reconstruction in our institute, the use of NSM is still limited. In our cohort, there are 6.9% NSMs performed, all of which are highly selected cases—no suspected cancer infiltration to NAC measured by imaging techniques, phyllodes tumor and prophylactic mastectomy. NSM, with preservation of the NAC, is reported to improve patients' satisfaction, body image, and psychological adjustment (12,13). However, the indication of NSM is still under debate. Multiple studies have demonstrated that tumor size, tumor location, LN metastasis, lymphovascular invasion, histologic type, immunological characteristics like HER2 should be taken into consideration when propose NSM to breast cancer patients (14-16). In terms of LRR of NSM, none of our cases developed loco-regional or distant recurrence because of relative short follow-up time and highly selective cases. According to previous studies, Orzalesi *et al*. reported loco-regional, NAC, systemic recurrence accounting for 2.9%, 0.7% and 1.0% respectively, with 0.7% death record among a 6-year study in Italy (17). NAC recurrence cases could be treated with NAC removal and had good prognoses, which suggested that NSM might be a safe procedure after selecting proper patients (18).

Despite NSM, same concerns was raised for all patients with breast reconstruction, that residual mammary tissue might be present and that breast reconstruction could negatively affected adjuvant chemotherapy and radiotherapy, especially in loco-regional control. Some study demonstrated that immediate breast reconstruction was associated with delay of adjuvant chemotherapy for women under the age of 60 (19); while another debated that immediate breast reconstruction did not delay adjuvant chemotherapy, compared with patients with no reconstruction (41 *vs*. 42 days, P=0.61) (20). As for post-mastectomy radiotherapy, Liljegren *et al*. found that the delivery of radiation was compromised in more than half of the patients underwent prosthesis-based immediate breast reconstruction, however the time from mastectomy to the start of radiotherapy was similar in reconstruction group versus non-reconstruction group (21). Kronowitz suggested

that immediate breast reconstruction did not pose negative impact on recurrence free survival in patients who received post-mastectomy radiotherapy in neither autologous tissue-based reconstruction nor implant-based reconstruction (22,23). In the current study, at a median follow-up time of 28.2 months, only 2.0% patients developed LRR, suggesting a satisfactory loco-regional control. Nevertheless, the interaction between breast reconstruction and adjuvant therapy was beyond the scope of our study.

Conclusions

The current study described a 15-year study of 951 breast reconstruction cases in FUSCC. The reconstruction cases increased over the years with the change of paradigm. Most strikingly, prosthesis-based reconstruction rapidly gained its prevalence and became the most common strategy in last year. Prosthesis-based reconstruction was associated with bilateral reconstruction, contralateral augmentation and higher complications. SSM was routinely performed for all reconstruction patients while NSM was only performed for highly selected patients. Patients with breast reconstruction were able to achieve satisfactory loco-regional control in our cohort.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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