

Oncoplastic Reconstructive Breast Surgeon (ORBS) Performance and Impact on Breast Reconstructions: Clinical Outcome, Learning Curve, and Patient Reported Aesthetic Results- An analysis of 451 Procedures

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Abstract

Oncoplastic and reconstructive breast surgeon (ORBS) aimed to incorporate aesthetics and plastic technique into breast cancer operations to balance the oncologic safety and cosmetic outcome, and also to promote breast reconstructions. The outcome of breast reconstruction performed by an ORBS was reported from a single institute. Among the 451 breast reconstructions performed by an ORBS, 75.8% were gel implant reconstructions, 3.3% were tissue expander, 16.9% were transverse rectus abdominal myocutaneous (TRAM) flap, 3.1% latissimus dorsi (LD) flap, and 0.9% LD flap + implant. The patients reported aesthetic evaluation showed that 53.9% responded excellent, 41.1% good, 4.4% fair, and 0.6% poor. In cumulative sum plot learning curve analysis, it took around 58 procedures for an ORBS to be familiar with mastectomy followed by immediate gel implant reconstruction and to significantly decrease the operation time. In multivariate analysis, younger age, MRI, nipple sparing mastectomy, ORBS, and high-volume surgeon were factors related to breast reconstructions. Current study demonstrated that a breast surgeon after adequate training could become an ORBS and perform breast reconstructions with adequacy. Complimentary to traditional breast surgeon-to-plastic surgeon breast reconstruction pathways, ORBS could increase breast reconstructions rate, which remained low worldwide.

Introduction

Breast reconstructive procedures and related surgical trainings have traditionally been performed by plastic surgeons, however, a paradigm shift has recently taken place[1-4]. A formal inter-specialty training program has been established in UK since 2002[2, 5]. Oncoplastic and reconstructive breast surgeon (ORBS) aimed to incorporate aesthetics and plastic technique into breast cancer operations to not only achieve the oncologic safety and cosmetic outcome simultaneously, and also to promote breast reconstructions[3, 6-8]. The ORBS training program was started in England and Europe, and now became widespread around the world[1-6, 8-11]. The program incorporated lectures and training courses to assist breast surgeons to acquire breast reconstruction techniques and plastic surgeons to be familiar with breast cancer operations (dual trained system)[1, 3, 8-10, 12].

In clinical practice, it is important to evaluate the quality of patient care and treatment[11, 13, 14], and the results and quality of the breast reconstructions performed by ORBS should be reported and monitored[12, 15]. Would breast reconstructions performed by ORBS achieve the same level of safety and satisfaction comparable to plastic surgeon (PS)? Would BS receiving ORBS training increase breast reconstruction rate? A few studies focusing on the results of breast reconstructions performed by ORBS have been reported [12, 15]. However, the type, quality, and impact of ORBS on breast reconstructions were rarely stated, and many questions remain unanswered.

It's time to evaluate the impact of ORBS on rate and quality of breast reconstructions, and studies are needed to objectively evaluate this dual-trained program[12]. The aim of current study is to evaluate the preliminary results of breast reconstructions program conducted by an ORBS in a single institute, and to evaluate patient reported outcomes (PRO) following breast reconstructions performed by ORBS. The

impact of the ORBS on the rate of breast reconstructions, the type and quality of breast reconstructions performed by the ORBS would be analyzed and reported.

Results

A total of 451 breast reconstructions procedures were performed by one ORBS (HWL) during study period, and 448 were immediate breast reconstructions (IBR) while 3 were delayed. Among the 448 mastectomies, 337 (75.2%) were nipple sparing related, and 34.4% (129/374) were associated with lymph node metastases. Among the 451 breast reconstructions performed by the ORBS, 342 (75.8%) were gel implant reconstructions, 15 (3.3%) were tissue expanders, 76 (16.9%) were TRAM flaps, 14 (3.1%) were LD flaps, and 4(0.9%) LD flap + implants. The clinical manifestations of these patients were summarized in Table 1. The pre- and post-reconstruction images were demonstrated in Figure 1.

Table 1

Clinical manifestations of patients received breast reconstructions by oncoplastic reconstructive breast surgeon.

N=451	Means \pm SD
Age, y	47.7 \pm 9.1
BMI	22.9 \pm 3.4
Location	
Right	236(52.3)
Left	213(47.2)
Breast operation Method (N/A=3)	
NSM	337 (75.2)
Subcutaneous mastectomy	40 (8.9)
Simple mastectomy	71(15.8)
Method of mastectomy	
#Endoscopic assisted total mastectomy	160(35.7)
#Robotic assisted nipple sparing mastectomy	75(16.7)
Conventional mastectomy	213(47.5)
Lymph node OP(N/A=10)	
SLNB	253(57.4)
ALND	46(10.4)
SLNB+ALND	75(17.0)
Not done	67(15.2)
Reconstruction type	
Gel implant	342(75.8)
Tissue expander	15(3.3)
Pedicle TRAM flap	76(16.9)
LD flap	14(3.1)
LD flap + Gel implant	4(0.9)
Lymph node stage (N/A=77)	
N0	245(65.6)

N1	93(24.9)
N2	26(7.0)
N3	10(2.7)
Stage (N/A=76)	
0	73(19.5)
I	93(24.8)
II	155(41.4)
IIIA	47(12.5)
IV	7(1.9)
Grade(N/A=95)	
I	58(16.3)
II	199(55.9)
III	99(27.8)
ER(N/A=75)	
Positive	298(79.3)
Negative	78(20.7)
PR(N/A=78)	
Positive	257(68.4)
Negative	116(31.6)
HER-2(N/A=123)	
Positive	76(23.2)
Negative	252(76.8)
NSM: nipple sparing mastectomy, SLNB: sentinel lymph node biopsy, ALND: axillary lymph node dissection, TRAM flap: transverse rectal abdominal musculocutaneous flap, LD flap: latissimus dorsi flap, # endoscopic or robotic assisted mastectomy and breast reconstructions cases are shown in supplementary file 1.	

Of the 451 (Table 2) mastectomies followed by IBR, the mean operation time was 304.8 ± 174.1 mins, and the mean resection mastectomy weight was 360 ± 235.6 gm. The mean reconstruction gel implant and flap weight was 310.5 ± 99.8 gm, and 576.3 ± 173.3 gm. Among the 361 implant related procedures,

the implant loss rate was 1.4%. There was no any total flap loss case among the 94 autologous flap reconstructions. The clinical outcome and peri-operative parameters of breast reconstructions performed by an ORBS were analyzed and summarized in Table 2. Compared with BS without reconstruction training, ORBS had performed more different types of breast reconstructions (Table 3). Moreover, ORBS had shown competency with PS in providing diverse types of breast reconstructions other than micro-surgery related procedures.

Table 2
clinical outcome of breast reconstructions performed by oncoplastic reconstruction surgeon

N=451	Means ± SD	
Operation time		
Mastectomy and immediate breast reconstruction time, min (N/A=46)	304.8±174.1	
Mastectomy time, min (N/A=106)	177.9±125.1	
Reconstruction time, min (N/A=50)	117.1±97.9	
Surgery blood loss		
Overall blood loss, ml	105.9±100.9	
Mastectomy blood loss, ml	66.6±69.6	
Reconstruction blood loss, ml	48.7±59.0	
Specimen weight, gm (N/A=21)	360.0±235.6	
Reconstruction Gel implant size, ml (n=361)	310.5±99.8	
Reconstruction TRAM Flap weight, gm (n=76)	576.3±173.3	
Length of stays, day(N/A=253)	5.8±2.1	
Implant failure/loss rate (n=361)		
No failure/loss	356(98.6)	
Failure/loss	5(1.4)	
Autologous flap failure rate (n=94)		
Flap no failure	94(100)	
Total flap loss	0(0)	
Learning curve analysis with cumulative sum plot case 58 th showed decreasing operation time		
Mean operation time of NSM + IGBR (n=342)	218±82.7	
Early learning phase (#1-#58)	326.6±105.4	P<0.01
After learning phase (#59-#361)	194.9±54.1	
Implant failure rate	1.4% (5/361)	
Early learning phase (#1-#58)	3.4%(2/58)	P=0.18
After learning phase (#59-#361)	1%(3/303)	
Blood loss	Mean blood loss=65.7 ± 49.8	
Early learning phase (#1-#58)	105 ± 47.026	P<0.01

After learning phase (#59-#361)	57.3 ± 46.3
Of these 5 implant failures, 2 from post BCS mastectomy, 2 large ptosis breasts, and 1 from infection from chemotherapy.	

A self-reported questionnaire was performed, and a total of 321 (71.2%) patients completed the survey and were included in the analysis. The patients responded cosmetic outcome evaluation showed that 53.9% (173/321) of them were excellent, 41.1% (132/321) good, 4.4% (14/321) fair, 0.6% (2/321) poor (Figure 2a). The cases experience accumulation and performance of ORBS was shown in Figure 2 b-f. The time needed for ORBS to complete mastectomy and IGBR decreased gradually (Figure 2b). The implant loss rates were 4% (2/50) in the first 50 implant-related breast reconstructions, 2% (1/50) in 51th to 100th cases, and 1% (1/100, Figure 2c) thereafter. The overall satisfaction rate of breast reconstructions increased in paralleled with accumulation of experiences (Figure 2d, e). In CUSUM plot learning curve analysis, it took around 58 procedures for an ORBS to be familiar with mastectomy and IGBR and significantly decreased operation time (Table 2, Figure 2f). During the study period, the distributions of breast reconstructions cases and their corresponding primary breast surgeons were shown in Figure 3a. The breast reconstruction referral rates varied widely from different breast surgeons. Factors related to breast reconstructions were evaluated (Table 4), and in multivariate factors analysis, younger age (Odds ratio, OR, 0.92), MRI performed (OR=3.74), NSM (OR:7.40), ORBS (OR:1.84), and high-volume surgeon (OR:6.96) were important factors related to breast reconstructions.

Table 3

Comparison of oncoplastic reconstruction breast surgeon, plastic surgeon, and breast surgeon at the same institute

Reconstruction type	BS	ORBS	P value	PS	ORBS	P value
Gel implant	43(100%)	342(75.8%)	0.02	274(88.7%)	342(75.8%)	<0.01
Tissue expander	0	15(3.3%)		0	15(3.3%)	
TRAM flap	0	76(16.9%)		17(5.5%)	76(16.9%)	
LD flap	0	14(3.1%)		9(2.9%)	14(3.1%)	
LD flap+Gel implant	0	4(0.9%)		6(1.9%)	4(0.9%)	
Fasciocutaneous rotation flap				2(0.6%)		
LD muscle flap+ STSG				1(0.3%)		
ORBS: oncoplastic reconstruction breast surgeon, BS: breast surgeon, PS: plastic surgeon, TRAM flap: transverse rectus myocutaneous flap, LD: latissimus dorsi, STSG (split-thickness skin graft)						

Table 4

Univariate and multivariate analyses of clinical and pathologic factors related to breast reconstructions

	Univariate Analysis			Multivariate Analysis		
	OR	95% CI	P	OR	95% CI	P
Age	0.90	0.89- 0.91	<0.01	0.92	0.90- 0.94	<0.01
BMI (>24)VS ≤24	0.48	0.40- 0.58	<0.01	0.74	0.52- 1.05	0.09
Pathology tumor size (invasive, cm)	1.03	0.99- 1.07	0.12			
MRI (Yes VS No)	3.38	2.72- 4.19	<0.01	3.74	2.07- 6.78	<0.01
Grade (II, III) VS I	0.53	0.41- 0.70	<0.01	0.60	0.35- 1.04	0.07
Stage (other VS 0)	0.79	0.62- 1.01	0.06			
Subtype (other VS Luminal A)	0.81	0.66- 0.98	0.03	1.31	0.79- 2.16	0.30
Lymph node metastasis (Yes VS No)	0.74	0.61- 0.90	<0.01	0.83	0.21- 3.38	0.80
Nipple sparing mastectomy (Yes VS No)	11.14	8.94- 13.88	<0.01	7.40	5.00- 10.96	<0.01
Nipple invasion (Yes VS No)	0.69	0.53- 0.91	<0.01	1.49	0.93- 2.38	0.10
ER (positive) VS negative	1.47	1.18- 1.84	<0.01	0.92	0.52- 1.65	0.79
PR (positive) VS negative	1.27	1.04- 1.56	0.02	1.10	0.65- 1.85	0.73
HER-2 (positive) VS negative	0.75	0.60- 0.92	0.01	1.25	0.81- 1.93	0.32
Ki -67 (>20)VS ≤20	0.73	0.58- 0.93	0.01	0.72	0.46- 1.12	0.14
ORBS VS other surgeon	3.56	2.81- 4.51	<0.01	1.84	1.21- 2.79	<0.01
High volume surgeon VS low volume surgeon	5.24	3.70- 7.41	<0.01	6.96	2.91- 16.68	<0.01

ORBS: oncoplastic reconstruction breast surgeon

Discussion

In current study, we reported the preliminary outcome of 451 breast reconstructions performed by one ORBS, who initially was a BS and received international oncoplastic and reconstructive breast surgery training program. The preliminary results showed that the clinical outcome was acceptable, and there was no total flap failure in autologous breast reconstructions. The implant failure rate was 1.4%, which was low compared to around 8% implant failure rate reported in a meta-analysis of breast cancer patients

with IBR[16]. We observed a high patient-reported satisfaction rate (Figure 2a), with 95% of the study population reporting being satisfied (good: 41.1%; excellent: 53.9%) which is comparable with an earlier study published by Roberson et al[15]. Moreover, an earlier report by He et al[13] also demonstrated that having breast surgeon specialists performed IBRs doesn't seem to negatively affect outcome. Additionally, we found that ORBS also had positive impacts on rate of breast reconstructions (Figure 3a, Table 4).

IBR with implant have been employed as a mainstream option of breast reconstructions after early breast cancer treatment [13, 17-19], and implant failure is an important quality-indicator for the performance of reconstructive surgeon[16]. According to literature review meta-analyses results, around 8% of breast cancer patients with IBR suffered from implants loss[16]. Another study, in which breast reconstructions were performed by breast surgeons, showed a 4.9% (11/223) of implant extrusion rate due to infection[15]. The 1.4% (5/361) implant failure rate from the ORBS in the current study is low and acceptable. Factors predisposing to implant loss had been reported, radiotherapy, uncontrolled infection, obesity, and ptosis breasts were important risk factors[15, 16]. Whenever patients with the above mentioned risk factors are indicated for IBR, autologous breast reconstruction would be a safe alternative[17-19].

A qualified ORBS should be able to provide immediate or delayed breast reconstructions, which include implant types and/or autologous breast reconstructions[3, 9, 15]. Other than 361 implant insertions, our breast reconstructions program by ORBS also performed 94 autologous flap breast reconstructions (76 TRAM flap, 18 LD flap, Figure 1, Table 1, 3), laparoscopically harvested omentum flap, and other local flaps for partial breast reconstructions or repair of soft tissue defects. Compared with BS, who did not receive oncoplastic reconstructive breast training and provided only implant type breast reconstructions, a trained ORBS was able to provide more diversity of breast reconstruction services and in the same time, demonstrated a similar level of competency to PS (SLL) at the same year-of-service for breast reconstructions without microsurgeries (Table 3). Usually ORBS do not receive formal micro-surgery related trainings, therefore whenever the breast reconstructions involving the use of microsurgery techniques, consultation with PS, who experienced with microsurgeries, is recommended.

The impact of cases accumulation to the performance of an ORBS was rarely reported. We found that the operation time decreased, and implant failure rate dropped from 4% to 1% during study period after more cases experience accumulated (Figure 2b, c). From CUSUM plot, about 58 procedures were required for an ORBS to be familiar with the procedures of mastectomy and IGBR (Table 2, and Figure 2f), and the operation time together with blood loss were significantly decreased after initial learning phase. The patients' reported satisfaction rate also increased steadily when more breast reconstructions performed by ORBS (Figure 2). These results supported that a BS after formally ORBS training could perform breast reconstructions and provided high quality services after adequate cases experience accumulated.

Breast reconstruction is traditionally going from breast cancer operation performed by BS (or general surgeon) then breast reconstruction part performed by PS[1, 12] (Figure 3b). This system had the

advantage of different surgeons perform the best part of their work, however, some disadvantages remained unsolved[1]. For example, if the breast surgeons do not refer patients for breast reconstructions (as shown in Figure 3a), then patients may not have the chance to have breast-reconstruction consultations or operations provided by PS[20-22]. Sometimes, the BS or at the hospital just do not have adequate PS to perform the breast reconstructions[21-25]. These were some of the reasons that breast reconstructions rate remained low (around 10-25%) around the world today[9, 21, 23, 26].

At our institute, and I believed some other hospitals in the world[1, 7, 9, 12, 13, 15], now adopted the two tracts system, which allowed both the traditional two-team system (BS performed breast cancer operations then PS do the breast reconstructions) or the ORBS system (ORBS or dual-trained surgeons[12] do the mastectomies and reconstructions, Figure 3b). Patients could be referred from BS to PS for breast reconstructions or BS could work with ORBS doing breast reconstructions. ORBS (or dual-trained surgeon[12]) are capable of carrying out breast cancer operations and breast reconstructions. Herrick et al.[12] had shown that patients received dual-train surgeons' services (mastectomy and reconstruction) required fewer doctor visit, and have significant socioeconomic and psychological benefits. In some cases, when breast reconstructions involving micro-surgeries, ORBS could work with PS for breast reconstructions.

The concept of ORBS, which originated in early 2000 in UK and Europe, was aimed to incorporate aesthetics and plastic technique into breast cancer operations, and to promote breast reconstructions[1-3, 5, 6]. In our multivariate analysis for factors predisposing breast reconstruction (Table 4), younger age (OR=0.92), breast MRI (OR=3.74), NSM (OR:7.40), ORBS (OR:1.84), and high-volume surgeon (OR:6.96) were important factors. Our findings supported that ORBS could increase breast reconstruction rate, and confirmed that the primary breast surgeons played import roles[20-22, 27, 28]. High volume surgeon (defined as cases larger than 100 per year) and ORBS were important contributing factors affected patients receiving breast reconstructions (Table 4, Figure 3a).

This study is limited due to its single institutional study without multi-centers' data to confirm the hypothesis that breast surgeons after adequate training could be transformed to ORBS and perform breast reconstructions with adequacy. As each BS received different surgical training and had quite different practice behaviors. The experience and results derived from current study might not be applied to other surgeons, hospitals or regions in the world. More studies and reports from other ORBS were needed to consolidate this concept. The questionnaire, which had been used and published in our previous studies[29-32], we used at current report was different from the common used questionnaire like "BREAST-Q"[14], and might not be so comprehensive and well adopted. Based on our experiences, a surgeon to be trained as an ORBS should be a certified breast surgeon, who is familiar with conventional breast cancer operations and treatment. Furthermore, he/she should receive reconstructive breast surgeries training in a high volume (≥ 100 cases per year) reconstructive breast surgeries centers with adequate training duration (≥ 6 months).

In conclusion, we demonstrated that a breast surgeon after adequate training could become an ORBS and perform breast reconstructions with adequacy. Following more cases' experience accumulations, the performance of ORBS increased gradually in term of decreasing operation time, less implants loss, and increased patients' reported satisfactions. In complimentary to traditional BS to PS pathways, ORBS could increase breast reconstructions, which were remained under-performed in the world.

Methods

Patients

Patients who received breast reconstructions from 1 January 2011 to 31 May 2020 were retrieved from a prospectively collected oncoplastic reconstructive breast surgery database at Changhua Christian Hospital, a tertiary medical center at central Taiwan. We started a breast reconstruction program by ORBS at our institution since 2011 after one of our breast surgeons (HWL), who is a certified breast surgeon and dedicated to breast cancer operations, received an international ORBS training program overseas at European institute of Oncology (EIO), Milan, Italy during the period from 1 Oct 2010 to 30 April 2011.

The data collected included clinicopathologic characteristics of patients, type of mastectomies, methods of breast reconstructions, operative time, blood loss, length of hospital stays, and major complications. All data were collected from chart review by specially trained nurses (CMT) and subsequently confirmed by the principle investigator (HWL). The study was approved by the Institutional Review Board of Changhua Christian Hospital, Changhua, Taiwan (CCH IRB No.: 150913 & 161114). Written informed consent pertaining to the use of clinical records was obtained from each participant. This current report includes photos of several patients who had agreed and signed the consent for publication of their pictures. All study procedures were performed in accordance with relevant guidelines and regulations.

Breast reconstruction methods

Breast reconstructions were performed immediately or at a later stage depending on patients'

conditions and preference. Breast reconstructions after mastectomy were performed using either an implant (cohesive gel implants, saline implant or tissue expander), autologous tissue with a latissimus dorsi (LD) flap or a pedicled transverse rectus abdominis myocutaneous flap (TRAM) flap[17-19] (Figure 1. and Supplementary file).

Clinical outcome and Patients- reported aesthetics results

The safety of breast reconstructions was monitored with operative time, hospital stay, and events of major complications. Brest reconstructions failure, defined as implant loss or total flap loss in autologous

breast reconstructions was regularly followed. The implant loss rate, which defined as explant due to surgery related complication occurred within 3 months post operation, was recorded.

Patients-reported aesthetic results following breast reconstruction were assessed using a self-administered questionnaire, which had been used in our previous studies[29-32]. The self-administered questionnaire, which was designed to evaluate the aesthetic result of breast cancer patients received breast reconstruction, was conducted at 3 months after the operation when their surgical wounds had healed.

The questionnaire comprised of 10 questions (supplementary file) and 4 itemized scales, which were graded as “1, poor”, “2, fair”, “3, good”, and “4, excellent”. To evaluate the overall satisfaction score of breast reconstructions, the total score of question #2 to 9 in each patient was tabulated. Those with an overall score of 8–11 was graded as poor, a score of 12–19 graded as fair, a score of 20–27 graded as good, and a score of 28–32 graded as excellent. Patients with results graded as ‘excellent’ or ‘good’ were defined as being satisfied with the cosmetic outcome.

Impact of cases experience accumulation, and competence of breast reconstructions performed by ORBS

To evaluate the impact of cases experience accumulation of ORBS and outcome of breast reconstruction, the total operation time needed for mastectomy and immediate gel implant reconstruction (IGBR), the events of implant loss, and patient-reported aesthetic results were arranged in chronologic sequence. The competency of ORBS in performance of breast reconstruction was further evaluated by comparing breast reconstructions types performed with different surgeons at the same hospital. One breast surgeon (BS), who performed breast reconstructions without formal oncoplastic breast reconstruction training, and another PS (SLL) the same years-of-service were selected for comparisons.

Learning curve evaluation of mastectomy and IGBR

Cumulative sum (CUSUM) plot analysis is a frequently adopted analytic method[33] for learning curve evaluation. To evaluate the impact of case experience accumulation for an ORBS on the operation time of mastectomy and IGBR, the “overall operation time” was gathered and plotted in a chronological order. The CUSUM plot[34] was used to analyze the learning curve, and a learning curve is considered complete when a point for decreasing surgical time was observed from the CUSUM plot. The “overall operation time” was defined as the time taken from the skin incision, mastectomy, gel implant reconstruction to the end of wound closure. The “overall operation time” also included the time taken for procedures such as axillary surgery, mastectomy, reconstruction with gel implants, drains placement, and wound closure.

Factors of breast reconstructions and impact of ORBS

Clinical and pathological factors related to breast reconstruction were also surveyed. Two groups of patients, which consisted of 850 breast reconstruction patients and another 1001 no breast reconstruction patients, were compared to identify clinical or pathologic factors related to breast reconstructions. Factors surveyed included age, body mass index (BMI), tumor size, breast MRI, histologic grade, stage, intrinsic subtypes, lymph node metastasis, NSM, nipple invasion, ER, PR, HER-2, Ki-67, surgeon type (ORBS versus other), and volume of surgeon (high volume versus low volume). High volume of surgeon was defined as breast cancer >100 cases per year.

To evaluate the impact of primary caring breast surgeon on patients' subsequent breast reconstructions, the case number and distribution of breast reconstructions were traced to their primary caring breast surgeons and listed in sequential year.

Statistical Analysis

Data are expressed as mean \pm standard deviation (SD) for continuous variables. We used the chi-square test for categorical comparisons of data, and differences in means of continuous variables were tested by the Student's t test. A p value of less than 0.05 was considered to indicate statistical significance and all tests were two-tailed. All statistical analyses were performed with the statistical package SPSS for Windows (Version 19.0, SPSS, Chicago) and the accuracy of the statistical results was confirmed by an experienced statistician (YJL).

Declarations

Author Contributions

H.W.L. was involved in manuscript drafting. J.L. and S.L.L were involved in methodological design. S.L.L. and Y.J.L. contributed to statistical analysis and interpretation. S.J.K carried out data collection and analysis. H.W.L, D.R.C and S.T.C were involved in study conceptualization and manuscript editing. All authors were joined to review this manuscript.

Ethics Declarations

The authors declare no competing interests.

Additional Information

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Competing interests

The authors declare no competing interests.

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Figures



Figure 1

Post-operation appearance of breast cancer pictures with various breast reconstruction. a-d. Conventional nipple sparing mastectomy (C-NSM) with gel implant reconstruction. a. Pre-operative front view of right breast cancer patients. b. Gel implant. c. Post-operative front view. d. Post-operative lateral view of C-NSM with gel implant breast reconstruction. e-h. Mastectomy with breast reconstruction with latissimus dorsi (LD) flap reconstructions. e. Front view of right breast cancer with skin invasion. f. Harvest of LD flap. g. Front view of post mastectomy with LD flap reconstruction. h. Back scar post LD flap harvest for breast reconstruction. i-l Left breast mastectomy with LD flap + gel implant reconstruction combined with contralateral gel implant insertion for breast augmentation mammoplasty. i. Left breast cancer underlying nipple areolar complex and near skin. j. Post mastectomy reconstruction with LD flap and implant insertion. k. Front view of post left mastectomy and breast reconstruction with LD flap + gel implant combined with contralateral gel implant breast augmentation. l. Left back scar post LD flap harvest. m-p Left breast mastectomy and transverse rectus abdominal myocutaneous (TRAM) flap reconstruction. m. Left breast cancer pre-operative front view. n. Left TRAM flap was harvested for breast reconstruction. o. Front view of left mastectomy and TRAM flap reconstruction. p. Lateral view of left mastectomy and TRAM flap reconstruction. q-t Conventional nipple sparing mastectomy and immediate breast reconstruction with TRAM flap. q. Pre-operative view of left breast cancer. r. Harvest of left TRAM flap for breast reconstruction. s. Front view of left NSM and TRAM flap breast reconstructions. t. Lateral view of left NSM and TRAM flap breast reconstructions.



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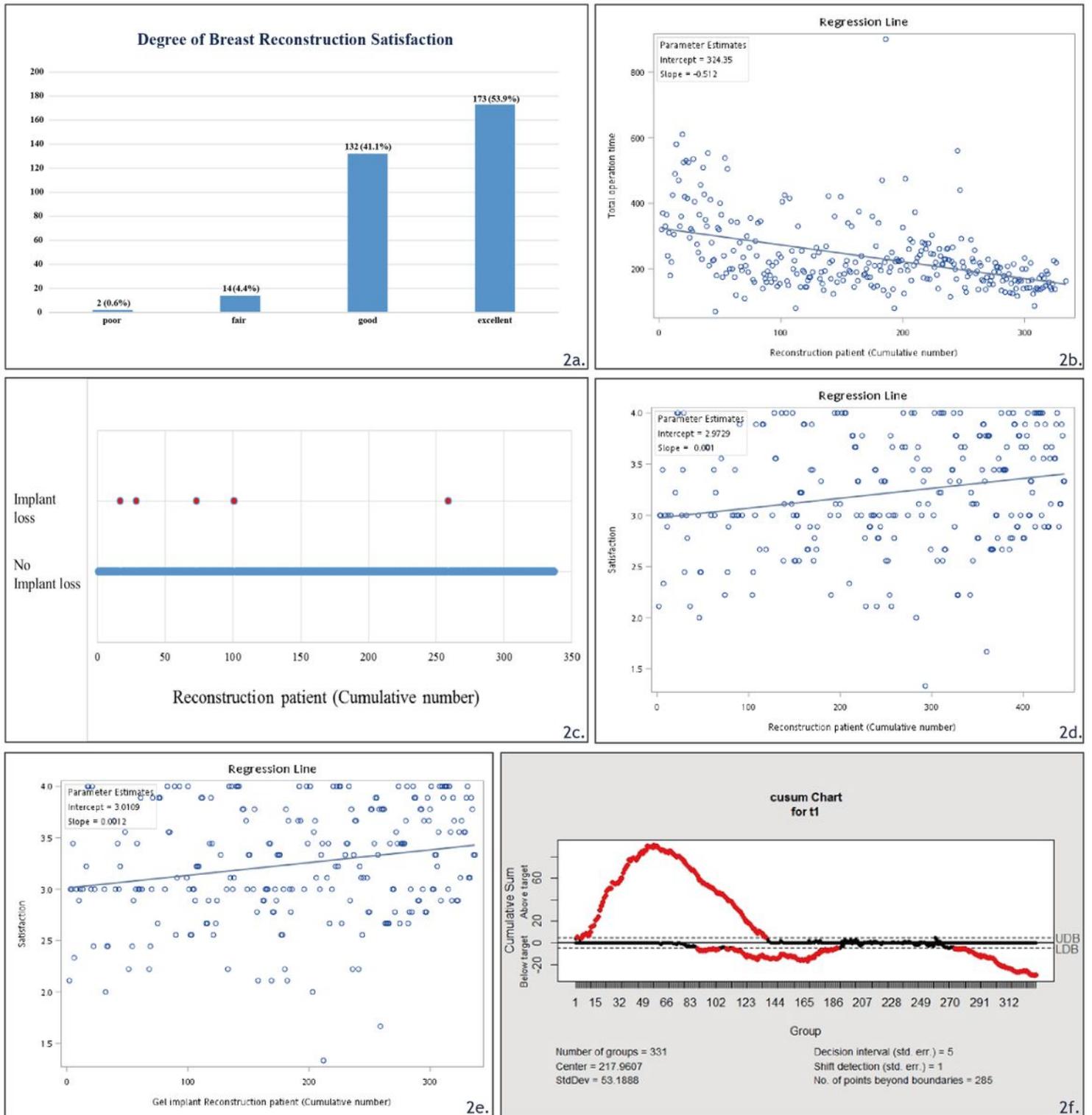


Figure 2

Patients-reported aesthetic results and cases experience accumulation to performance of oncoplastic reconstructive breast surgeon (ORBS). a. Patients-reported aesthetic results performed by oncoplastic breast surgeon (HWL) was shown. The patients-reported aesthetic results showed that breast reconstructions performed by ORBS was associated with overall 95% satisfaction rate. b. Operation time and cases accumulation. After more cases experience accumulation, the operation time decreased

significantly. c. Implant loss events and cases accumulation. The implant loss rates were 4% (2/50) in the first 50 implant-related breast reconstructions, 2% (1/50) in 51th to 100th cases, and 1% (1/100) thereafter. d. Patients satisfaction of all type breast reconstructions and cases accumulations. The overall satisfaction rate of breast reconstructions increased paralleled with more cases experience accumulated. e. Patients satisfaction of implant type breast reconstructions and cases accumulations. The overall satisfaction rate of implant type breast reconstructions increased paralleled with more cases experience accumulated. f. Cumulative sum plot of learning curve for ORBS performing mastectomy and immediate gel implant breast reconstruction (IGBR). It showed that it took 58 procedures for the ORBS to familial mastectomy and IGBR, and showed significantly decreased operation time.

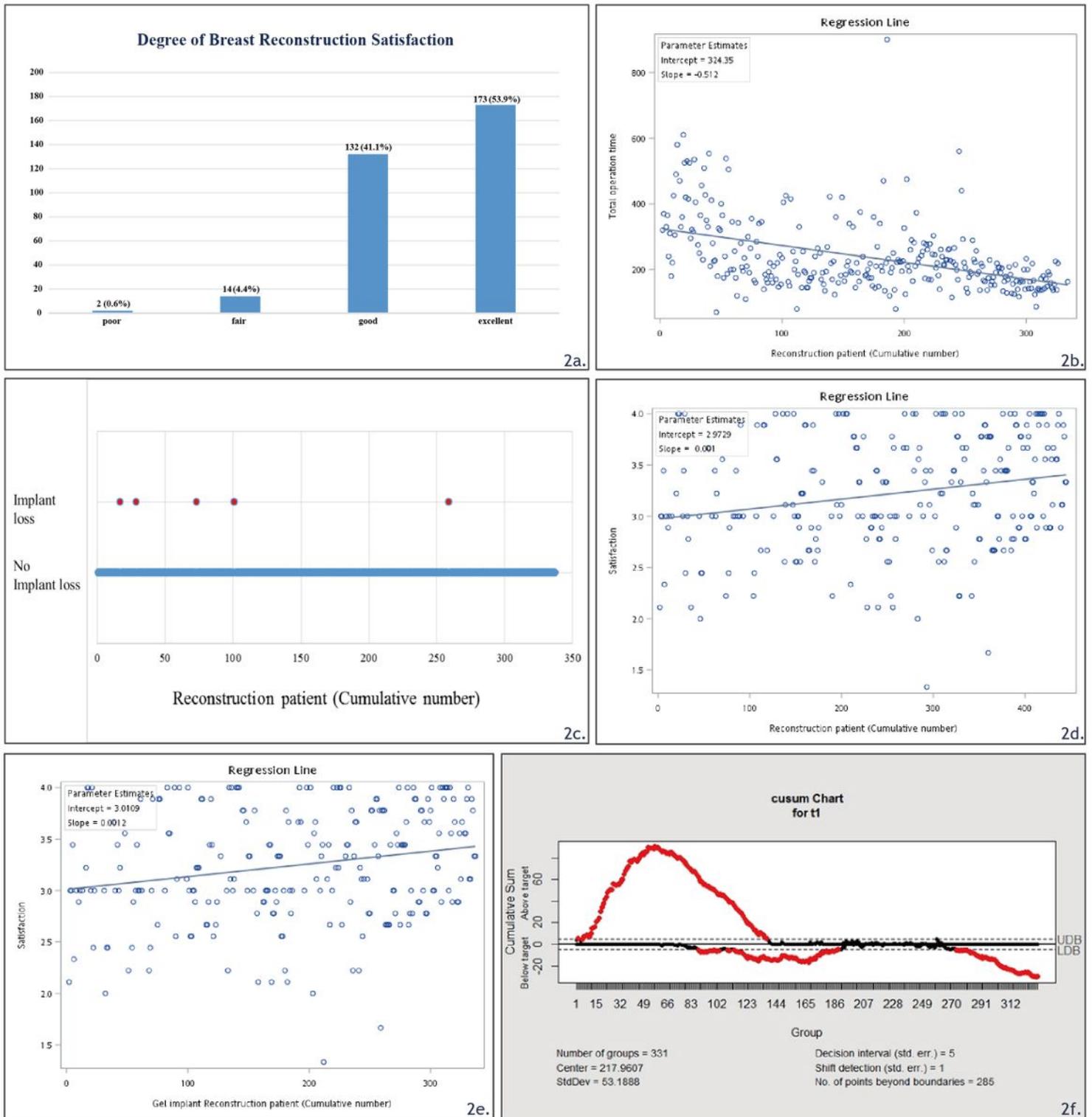
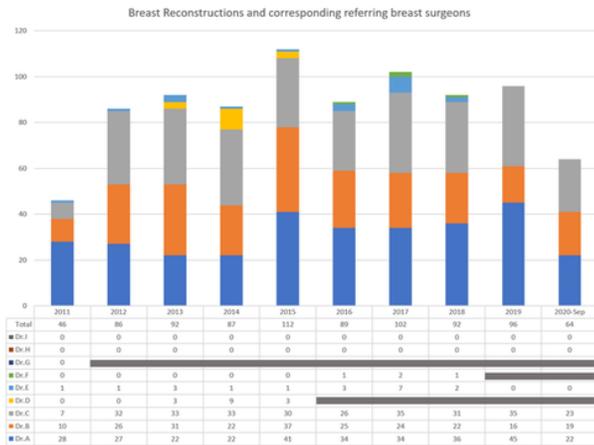


Figure 2

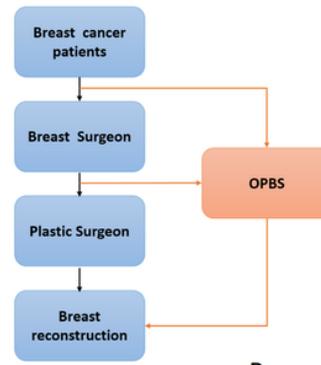
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A

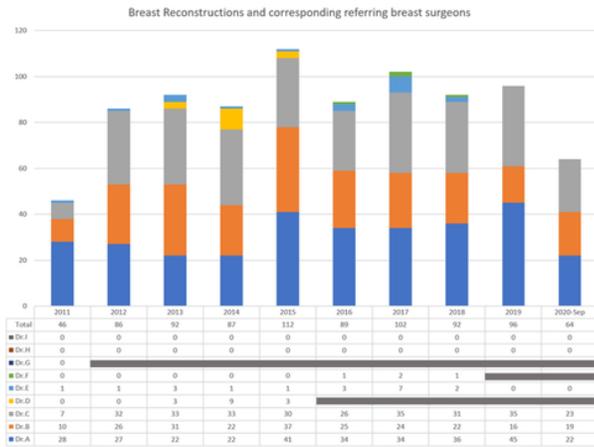
Breast Reconstructions Algorithm Pathways



B

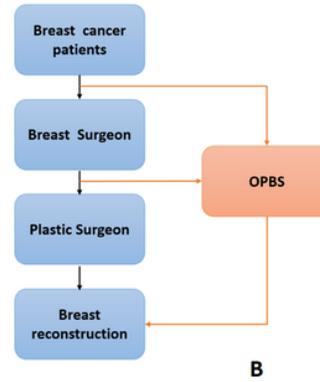
Figure 3

Impact of breast surgeons on breast reconstructions and proposed algorithms for breast reconstruction. a. Breast reconstructions and referring breast surgeons. One could observe that patients received breast reconstructions varied widely from corresponding breast surgeons. Some doctors rarely or did not refer breast reconstructions during study period. b. Two tract breast reconstruction programs. Breast reconstruction is traditionally going from breast cancer operation performed by BS (or general surgeon) then breast reconstruction part performed by PS. ORBS system (ORBS do the mastectomies and reconstructions). Patients could be referred from BS to PS for breast reconstructions or BS could work with ORBS doing breast reconstructions. ORBS could do breast cancer operations and breast reconstructions. In some cases, when breast reconstructions involving micro-surgeries, ORBS could work with PS for breast reconstructions.



A

Breast Reconstructions Algorithm Pathways



B

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