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Outcomes Comparison for Microsurgical Breast Reconstruction in Specialty Surgery Hospitals Versus Tertiary Care Facilities

Rahul Vemula, MD*
Matthew J. Bartow, MD†
Matt Freeman, MD*
Cameron Callaghan, MD*
Tim Matatov, MD*
David Jansen, MD*
Bob Allen, MD†
Hugo St. Hilaire, MD, DDS†
Oren Tessler, MD, MBA†

Background: Postoperative monitoring is crucial in the care of free flap breast reconstruction patients. Tertiary care facilities (TCFs) provide postoperative monitoring in an ICU after surgery. Specialty surgery hospitals (SSHs) do not have ICUs, but these facilities perform free flap breast reconstruction as well. Are outcomes comparable between the 2 facilities in terms of flap reexploration times and overall success?

Methods: Retrospective study including 163 SSH and 157 TCF patients. Primary predictor was facility in which the procedure was performed. Secondary predictors included operative, demographic, and comorbidity data. Primary outcomes were flap take back rate and flap failures. Secondary outcomes were total time from adverse event noticed in the flap to returning to the operating room (OR) and total time from decision made to return to the OR to returning to the OR (decision made). Tertiary outcomes were length of stay, operative times, and blood loss.

Results: Patients at the TCF were generally less healthy than SSH patients. Salvage rates and failure rates were similar between the 2 institutions. Adverse event noticed and decision made times did not differ between the 2 facilities. Overall flap success rate was 98.22% at SSH and 98.81% at TCF. No primary or secondary predictors had a significant correlation with increased odds for flap failure.

Conclusion: SSHs can offer similar outcomes in free flap breast reconstruction with just as effective clinical response times to endangered flaps as found in a TCF. However, surgery at an SSH may best be reserved for healthier patients. (Plast Reconstr Surg Glob Open 2017;5:e1514; doi: 10.1097/GOX.0000000000001514; Published online 10 October 2017.)

INTRODUCTION

Since free flap breast reconstruction was first described in the 1970s by Fujino et al.[1], the field has undergone exponential growth to the point where free tissue transfer for breast reconstruction have now become commonplace. The field has since evolved from using free myocutaneous flaps such as the transverse rectus abdominus myocutaneous flap, to using multiple perforator flap options, such as the deep inferior epigastric artery perforator (DIEP) flap, superior gluteal artery perforator (SGAP) flap, Inferior Gluteal Artery Perforator flap, Profunda Artery Perforator flap, and so on.[2,3]

*From the *Tulane University School of Medicine, New Orleans, La.; †Louisiana Health Science Center – New Orleans, New Orleans, La.*
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Free flap breast reconstruction—along with free flap surgery in general—requires stringent postoperative monitoring of the patient. The most fragile time for a free flap reconstruction when it is most prone for failure is within the first 72 hours, especially the first 24 hours.[4–7] Therefore, stringent monitoring is absolutely critical during this time.[8] Technological advances and new instruments such as implantable Doppler monitors, video monitoring, spectroscopy, tissue oximetry, and fluorescence angiography have emerged to further enhance success and salvage rates of free flap procedures.[9,10] Currently, salvage rates of free flaps requiring reexploration have been demonstrated to reach as high as 93% most likely due in part to these technological advances.[11] However, no technology can replace direct clinical observation.

Astute clinical observation is required because prompt return to the operating room to restore adequate perfusion of a flap determines the success of salvaging that flap. The ability to observe an adverse event in a postoperative

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free flap and take that flap back to the OR in a prompt fashion has been demonstrated as critical to the salvage of that tenuous flap.[4] Shortening the time of vascular insult to a flap by quickly observing changes to the flap, quickly deciding a flap must return to the operating room, and surgically restoring perfusion to the flap all dictate the survival of the flap. Traditionally, free frap breast reconstruction has been performed at tertiary care facilities (TCFs) with postoperative intensive care unit (ICU) monitoring for the first 24–48 hours postoperation. This observation regimen has been noted by some as absolutely critical to the survival and possible salvage of free flaps.[12]

As the reliability of these procedures has progressed over the years, some have called into question the need for stringent ICU monitoring.[13] ICU stays are the most expensive units per diem in the hospital and consume a massive amount of hospital resources. One estimate cites that ICU floors use 3 times the amount of nursing hours per patient day than a regular ward. When comparing ratios between the cost of an ICU and a regular unit bed, the difference can range anywhere from 2:1 to 3:1 depending on the characteristics of the facility. Further, it has been noted that ICUs generate nearly 20% of total expenditures for a hospital.[14] These ICUs are traditional surgical intensive units and not dedicated microsurgical observation units; therefore, these relatively medically stable patients are utilizing resources that could be better sourced for medically tenuous patients.

Unlike TCF, specialty surgery hospitals (SSHs) typically have lower patient volume, more specialized nursing care throughout the facility, and no ICU. Given the fact that breast reconstruction is an elective procedure, there is a contingency of patients undergoing these procedures that are relatively healthy and may require few if any ancillary monitoring other than flap integrity—warranting the movement of these procedures away from academic and TCF to special surgical centers.[15] There are no current data in the literature that performing microsurgical autologous breast reconstruction fare better in tertiary care centers with available ICU rather than in a specialized surgical center. In this study, we perform a side-by-side comparative outcome analysis for microsurgical breast reconstruction performed at these 2 types of facilities.

METHODS

Study Design/Sample

This study was a 2-institution retrospective cohort study. Upon institutional review board (IRB) approval, a retrospective hospital chart review was conducted of all free flap breast reconstructions performed at a SSH and a high-volume free flap breast reconstruction TCF. Inclusion criteria included all free flap breast reconstructions successfully completed as identified by current procedural terminology codes 19364 and S2068 between the study dates of January 2008 and November 2014. Exclusion criteria included any patient who was converted from a free to a pedicled flap, any aborted procedure, and any patient who received a stacked flap.

STUDY VARIABLES

Predictors

The primary study predictor variable was the facility in which the patient received their procedure (SSH/TCF). Secondary predictor included patient demographic and clinical data that may have a clinical impact on free flap breast reconstruction outcomes. They include patient age, body mass index (BMI), smoking status, chemotherapy, radiation therapy, use of implantable Doppler, performing surgeon, and comorbidities such as diabetes and hypertension, and whether a bilateral free flap procedure was performed.

Outcomes

The primary outcome measures were return to the operating room (OR) (flap take-back) and flap failures. Secondary outcome measures were lag time from adverse event noticed to returning to the OR (minutes) and time from decision made to take the flap back to returning to OR (minutes). Tertiary outcome measurements included estimated blood loss during free flap procedure (mL), operative time (minutes), and length of hospital stay (days).

Statistical Analyses

Deidentified data were entered into a statistical database (SPSS, IBM, Armonk, N.Y.) for analysis. General demographic data between all patients at the SSH and TCF were compared with descriptive statistics. T test was performed to compare the averages of the secondary predictor variables based on facility. Chi-square was performed to analyze significant differences in flap loss and take backs by individual surgeons. T test was used to compare averages of the tertiary outcome measurements. Logistic regression was performed to identify associations between the primary and secondary predictors and reexploration of a flap. Logistic regression was then performed to identify associations between the primary and secondary predictors and flap failure. T test was performed to compare the averages of the secondary predictor variables based on facility. T test was used to analyze difference in take back times of both institutions overall, times in salvaged flaps, and times in flaps that failed. Afterwards, a subanalysis was performed using the identical steps as described above for DIEP flaps only performed at each respective institution.

RESULTS

All Patients

The study sample comprised 320 patients—163 at SSH (50.94%) and 157 at TCF (49.06%). Average age at SSH was 49.76±9.04 compared with average age at TCF of 53.40±9.82. Average BMI at SSH was 27.22±5.51 and 30.65±6.26 at TCF. Average number of comorbidities per patient was 0.85±1.06 at SSH compared with 1.47±1.14 at TCF. Moreover, number of patients with diabetes and hypertension was significantly higher in the TCF patient group (17.83% versus 3.07% and 44.59% versus 25.15%, respectively). These variables were significantly different

Table 1. Demographic Data of All Flaps

Demographic Data	SSH	TCF	*P*
Patients	163	157	
Age (± SD)	49.76 (± 9.04)	53.40 (± 9.82)	0.01*
BMI (± SD)	27.22 (± 5.51)	30.65 (± 6.26)	0.01*
No. comorbidities (± SD)	0.85 (± 1.06)	1.47 (± 1.14)	0.01*
Smoker (%)	9 (5.52)	9 (5.73)	0.94
Diabetes mellitus (%)	5 (3.07)	28 (17.83)	0.01*
Hypertension (%)	41 (25.15)	70 (44.59)	0.01*
Radiation (%)	58 (35.58)	57 (36.31)	0.97
Chemotherapy (%)	74 (45.40)	69 (43.95)	0.96
Implantable Doppler	85 (52.15)	136 (86.62)	0.01*
ASA (± SD)	2.14 (± 0.63)	2.15 (± 0.39)	0.96
Airway class (± SD)	1.53 (± 0.68)	1.72 (± 0.59)	0.01*
Preoperative hemoglobin (gm/dL) (± SD)	12.98 (± 1.02)	12.65 (± 1.32)	0.01*
Preoperative hematocrit (vol%) (± SD)	38.77 (± 3.21)	38.21 (± 3.89)	0.17

* denotes $P > 0.05$. ASA indicates American Society of Anesthesiologists physical status classification.

Table 2. Flaps Stratified by Facility

Flaps By Facility			
SSH		TCF	
DIEP	224	DIEP	245
TUG	26	TRAM	5
PAP	22	SGAP	2
SGAP	5		
Circumflex femoral perforator	1		
DFAP	1		
IGAP	1		
SIEA	1		

DFAP, deep femoral artery perforator flap; IGAP, inferior gluteal artery perforator flap; PAP, profunda artery perforator flap; TRAM, transverse rectus abdominus muscle flap.

between the 2 institutions. Implantable Doppler use, airway class, and preoperative hemoglobin was significantly different between the 2 institutions as well (Table 1). There was a greater variety of flaps performed at the SSH (Table 2). There was no significant difference between delayed or immediate flap reconstruction between the 2 institutions ($P = 0.58$).

In terms of tertiary outcome measurements—when stratifying based on unilateral or bilateral procedures being performed—operative time and length of stay were significantly higher at the TCF (Table 3).

Eighteen of 281 flaps (6.76%) at the SSH were taken back to the OR for reexploration; 14 of these 18 flaps (77.78%) were salvaged; this yielded a 98.22% (276 of 281) success rate. Twelve of 252 flaps (4.76%) at the TCF were taken back to the OR for reexploration; 9 of these 12 flaps (75.00%) were salvaged; this yielded a 98.81% (249 of 252) success rate. Average take back time to OR after an adverse event was recognized (adverse event noticed) was 148.28±51.78 minutes at the SSH, compared with 216.08±156.19 minutes at the TCF. Average take back time to OR after decision was made to take the flap back was 87.00±35.55 minutes at the SSH, compared with 113.83±77.92 minutes at the TCF. Neither of these parameters were significantly different (Table 4). There was no significant correlation between particular surgeons and flap take back or flap loss. No significant difference was found in times for taking back a flap that was salvaged or in taking back a flap that failed (Table 5).

Based on logistic regression for return to the OR, no primary or secondary predictors had a significant correlation with increased odds for flap take-back, except for chemotherapy that had a negative correlation with flap take back (OR, 0.38; 95% CI, 0.16–0.88; $P = 0.02$). Based on logistic regression for flap failure, there were no significantly correlating predictor variables including lag time to OR after adverse event noted and time to OR after the decision was made to bring the flap back to the OR (Table 6).

DIEP

Average age, average BMI, average number of comorbidities per patient, number of patients with diabetes and hypertension were significantly higher in DIEP flap TCF patients similar to data shown in the overall analysis. The rest of the demographic data are shown in Table 7. Tertiary outcomes are summarized in Table 8.

Salvage rates and overall success rates were comparable between the 2 institutions. Neither average take back time to OR after an adverse event was recognized, nor the average take back time to OR after decision was made to take the flap back were significantly different between the 2 institutions (Table 9). There was no significant correlation between particular surgeons and flap take back or flap loss either. No significant difference was found in times for taking back a flap that was salvaged or in taking back a flap that failed (Table 10).

Based on logistic regression for take back, no primary or secondary predictors had a significant correlation with increased odds for take back. Based on logistic regression for flap failure, no primary or secondary predictors had a significant correlation with increased odds for flap failure (Table 11).

DISCUSSION

Free flap breast reconstruction in the modern setting can now approach success rates upward of 95% in demonstrated studies.[8,16] This technique can offer natural ap-

Table 3. Tertiary Outcomes

Tertiary Outcomes	SSH	TCF	*P*
Unilateral			
Estimated blood loss (mL) (± SD)	185.23 (± 124.57)	162.93 (± 67.25)	0.25
OR time (min) (± SD)	279.33 (± 74.55)	336.95 (± 110.12)	0.01*
Length of stay (d) (± SD)	3.60 (± 0.82)	4.38 (± 1.14)	0.01*
Bilateral			
Estimated blood loss (mL) (± SD)	258.38 (± 222.01)	216.58 (± 112.55)	0.09
OR time (min) (± SD)	401.99 (± 95.37)	473.05 (± 104.46)	0.01*
Length of stay (d) (± SD)	3.86 (± 0.73)	4.43 (± 1.12)	0.01*

Table 4. Complications Data for Flaps

Complications Data for Flaps	SSH	TCF	*P*
Flaps	281	252	
Take backs (%)	19 (6.76)	12 (4.76)	0.26
POD of take back (± SD)	0.61 (± 0.61)	2.00 (± 2.24)	0.18
Time from recognition of adverse event to entering OR (min) (± SD)	148.28 (± 51.78)	222.27 (± 162.26)	0.08
Time from decision made by physician to take flap back to entering OR (min) (± SD)	87.00 (± 35.55)	114.36 (± 81.70)	0.22
Salvaged (% of take backs saved)	14 (73.68)	9 (75.00)	1.00
Overall success rate (all flaps—unsalvaged/all flaps %)	98.22	98.81	

* denotes $P > 0.05$.

POD, postoperative day.

Table 5. Take Back Time of Failed and Salvaged Flaps

Take Back Time of Failed and Salvaged Flaps		SSH	TCF	*P*
Failed	*n*	4	3	
	Time from recognition of adverse event to entering OR (min) (± SD)	158.50±48.86	179.67±73.79	0.66
	Time from decision made by physician to take flap back to entering OR (min) (± SD)	80.25±23.68	93.00±13.08	0.45
Salvaged	*n*	14	9	
	Time from recognition of adverse event to entering OR (min) (± SD)	145.36±53.99	228.22±177.54	0.11
	Time from decision made by physician to take flap back to entering OR (min) (± SD)	88.93±38.79	120.78±89.94	0.25

Table 6. Logistic Regression for Take Back and Flap Loss

Logistic Regression for Take Back and Flap Loss	OR	95% CI	*P*
Take back			
Facility	—	—	0.29
Age	—	—	0.89
BMI	—	—	0.18
Bilateral	—	—	0.84
Surgeon	—	—	0.16
Smoker	—	—	0.67
Radiation	—	—	0.81
Chemotherapy	0.39	0.17–0.90	0.03*
Diabetes	—	—	0.49
Hypertension	—	—	0.57
No. comorbidities	—	—	0.55
Implantable Doppler	—	—	0.80
Flap loss			
Facility	—	—	0.93
Time from recognition of adverse event to OR	—	—	0.78
Time from decision made to take flap back to entering OR	—	—	0.51
Age	—	—	0.41
BMI	—	—	0.32
Bilateral	—	—	0.71
Surgeon	—	—	0.75
Smoker	—	—	0.57
Radiation	—	—	0.87
Chemotherapy	—	—	0.87
Diabetes	—	—	0.38
Hypertension	—	—	0.93
No. comorbidities	—	—	0.42
Implantable Doppler	—	—	0.06

* denotes $P > 0.05$.

pearing aesthetics to breast reconstruction. As a broad statement, most early free flap procedures were performed at tertiary care centers, whether academic or nonacademic.[17] Hopkinsmed.org defines "tertiary care" as "Specialized consultative care, usually on referral form primary or secondary medical care personnel, by specialists working in a center that has personnel and facilities for special investigation and treatment."[18] By extrapolation a "Tertiary Care Facility" is a hospital that provides health care from specialists in a large hospital after referral from primary and secondary care physicians. In essence, a TCF is a hospital taking care of a variety of patients and provides a variety of medical services: specialized surgery, trauma surgery, emergency medicine, medical intensive care, surgical intensive care, and so forth. These characteristics are mostly associated with facets of an "academic hospital" or a "teaching hospital." A specialized surgical center in contrast is a hospital offering surgical services to patients and has inpatient beds for appropriate postoperative recovery tailored specifically to the surgeries performed in that particular facility.

Clinical monitoring of free flaps is widely considered the gold standard for detecting adverse events in the postoperative period and has been the cornerstone for postoperative free flap management.[4,9,15,19,20] Free flaps at a TCF are most commonly transferred to an ICU postoperatively for monitoring. The employees most heavily relied upon for clinical monitoring are the nursing staff. Typically in an ICU as compared with a regular ward, the nursing staff is trained more rigorously, and a nurse has fewer patients assigned to them allowing closer patient observation to occur. However, the heterogeneity of patients in an ICU and unpredictable events within a unit of that nature may lead to less attention being paid to free flaps.

One advantage an SSH can provide is specialized nursing staff deliberately trained to monitor vascular integrity of a free flap. Rather than monitoring occurring in an ICU with a variety of patients, an SSH can provide specialized nursing staff trained in monitoring recovery of intricate procedures and monitoring patients solely recovering from special surgical procedures.

The null hypothesis that there is no difference between performing free flap breast reconstruction at an SSH when compared with a TCF. The overall success rate of these procedures, as well as overall salvage rates were comparable. Furthermore, the times to return an endangered flap to the OR for reexploration were comparable

Table 7. Demographic Data for DIEP Flaps

Demographic Data for DIEP Flaps	SSH	TCF	*P*
Patients	128	152	
Age (± SD)	50.00 (± 8.61)	53.01 (± 9.78)	0.01*
BMI (± SD)	28.20 (± 5.66)	30.73 (± 6.32)	0.01*
No. comorbidities (± SD)	0.91 (± 1.08)	1.46 (± 1.13)	0.01*
Smoker (%)	7 (5.47)	9 (5.92)	0.87
Diabetes mellitus (%)	4 (3.13)	27 (17.76)	0.01*
Hypertension (%)	34 (26.56)	68 (44.74)	0.01*
Radiation (%)	44 (34.38)	55 (36.18)	0.63
Chemotherapy (%)	59 (46.09)	67 (44.08)	0.88
ASA (± SD)	2.23 (± 0.61)	2.14 (± 0.38)	0.13
Airway class (± SD)	1.57 (± 0.71)	1.73 (± 0.60)	0.047*
Preoperative hemoglobin (gm/dL) (± SD)	12.93 (± 1.06)	12.65 (± 1.33)	0.051
Preoperative hematocrit (vol%) (± SD)	38.60 (± 3.42)	38.23 (± 3.94)	0.41

* denotes $P > 0.05$.

Table 8. Tertiary Outcomes of DIEP Flaps

Tertiary Outcomes of DIEP Flaps	SSH	TCF	*P*
Unilateral			
Estimated blood loss (mL) (± SD)	180.00 (± 94.87)	161.11 (± 66.35)	0.30
OR time (min) (± SD)	296.57 (± 79.99)	332.50 (± 102.09)	0.10
Length of stay (d) (± SD)	3.75 (± 0.80)	4.37 (± 1.01)	0.01*
Bilateral			
Estimated blood loss (mL) (± SD)	263.29 (± 231.92)	217.09 (± 112.81)	0.08
OR time (min) (± SD)	405.91 (± 96.59)	470.71 (± 102.60)	0.01*
Length of stay (d) (± SD)	3.89 (± 0.62)	4.41 (± 1.15)	0.01*

Table 9. Complications Data for DIEP Flaps

Complications Data for DIEP Flaps	SSH	TCF	*P*
Flaps	228	250	
Take backs (%)	15 (6.57)	11 (4.40)	0.14
POD of take back (± SD)	0.61 (± 0.61)	1.64 (± 2.01)	0.09
Time from recognition of adverse event to entering OR (min) (± SD)	152.07 (± 55.04)	211.72 (± 163.05)	0.20
Time from decision made by physician to take flap back to entering OR (min) (± SD)	91.52 (± 37.43)	116.55 (± 81.13)	0.30
Salvaged (% of take backs saved)	11 (73.33)	9 (81.82)	0.61
Overall success rate [(all flaps—unsalvaged/all flaps)%]	98.24	96.40	

Table 10. Take Back Time of Failed and Salvaged DIEP Flaps

Take Back Time of Failed and Salvaged DIEP Flaps		SSH	TCF	*P*
Failed	*n*	4	2	
	Time from recognition of adverse event to entering OR (min) (± SD)	158.50±48.86	137.50±14.85	0.60
	Time from decision made by physician to take flap back to entering OR (min) (± SD)	80.25±23.68	97.50±14.85	0.41
Salvaged	*n*	11	9	
	Time from recognition of adverse event to entering OR (min) (± SD)	149.73±59.18	228.22±177.54	0.18
	Time from decision made by physician to take flap back to entering OR (min) (± SD)	95.64±41.51	120.78±89.94	0.42

as well. Of note, however, there were differences in the tertiary outcome variables in terms of operative time and length of stay after the initial procedure.

The patients in this study receiving care at an SSH had lower BMI, age, and number of comorbidities. This is perhaps due to the surgeon selecting out patients with parameters that would predispose to poorer postsurgical courses. However, patient outcomes is not the crux of the analysis for this study. This study was designed to examine whether more specialized monitoring provided by an SSH—and not ICU admission at a TCF—had demonstrably better outcomes with regard to time noticing a vascular insult to a free flap and therefore coordinating the take back of that flap to the OR in a faster manner where actual surgical intervention to salvage that flap can take place. Although in absolute terms the SSH did have overall faster times to return to the operating room, these differences were not statistically significant. Even more so with regard to secondary outcomes, given the more medically tenuous state of health of the TCF patients, one could argue that these patients are more prone to flap failure; however, success rates were not significantly different between the 2 institutions.

CONCLUSIONS

In the properly selected patient, free flap breast reconstruction can be safely performed in an SSH. Such

Table 11. Logistic Regression for DIEP Flap Take Back and Flap Loss

Logistic Regression for DIEP Flap Take Back and Flap Loss	OR	95% CI	*P*
Take back			
Facility	—	—	0.15
Age	—	—	0.74
BMI	—	—	0.80
Surgeon	—	—	0.13
Smoker	—	—	0.72
Radiation	—	—	0.45
Chemotherapy	—	—	0.07
Diabetes	—	—	0.53
Hypertension	—	—	1
No. comorbidities	—	—	0.92
Flap loss			
Facility	—	—	0.61
Time from recognition of adverse event to OR	—	—	0.52
Time from decision made to take flap back to entering OR	—	—	0.44
Age	—	—	0.49
BMI	—	—	0.43
Surgeon	—	—	0.56
Smoker	—	—	0.42
Radiation	—	—	0.94
Chemotherapy	—	—	0.94
Diabetes	—	—	0.35
Hypertension	—	—	0.77
No. comorbidities	—	—	0.58

patients were found to have a quicker return to the operating room once a decision to return has been made. Medical and surgical floor nurses can be successfully trained to monitory free flap patients in a non-ICU setting, thus bypassing the need for an ICU admission. This may lead to cost savings for the healthcare system as well as providing greater access to ICU settings for medically ill patients who would greatly benefit from such an environment. One lesson demonstrated in this study is that for the properly selected patient, performing free flap breast reconstruction at an SSH is appropriate and may help vacate ICU beds at a tertiary care facility that would be better utilized by being occupied by a truly sick patient.

Oren Tessler, MD, MBA
Louisiana Health Science Center – New Orleans
1542 Tulane Ave, Rm 734
New Orleans, LA 70112
E-mail: otessl@lsuhsc.edu

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