Outcomes Analysis of Microsurgical Physiologic Lymphatic Procedures for the Upper Extremity from the United States National Surgical Quality Improvement Program (NSQIP)

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Introduction

Physiologic microsurgical procedures to treat lymphedema include vascularized lymph node transfer (VLNT) and lymphovenous bypass (LVB). The purpose of this study was to assess 30-day outcomes of VLNT and LVB using the National Surgical Quality Improvement Program (NSQIP) database.

Methods

NSQIP was queried (2012-2018) for lymphatic procedures for upper extremity lymphedema after mastectomy. Prophylactic lymphatic procedures and those for lower extremity lymphedema were excluded. Outcomes were assessed for 3 groups: (1) LVB, (2) VLNT, and (3) patients who had procedures simultaneously (VLNA+LVB). Primary outcomes measured were operative time, thirty-day morbidities, and hospital length of stay.

Results

The study included 199 patients who had LVB (n=43), VLNT (n=145), or VLNT+LVB (n=11). There was no difference in co-morbidities between the groups (p=0.26). Thirty-day complication rates including unplanned reoperation (6.9% VLNT versus 2.3% LVB) and readmission (0.69% VLNT versus none in LVB) were not statistically significant (p=0.54). Surgical site infection, wound complications, deep vein thromboembolism, and cardiac arrest was also similar among the three groups. Postoperative length of stay for VLNT (2.5 days±2.3), LVB (1.9 days±1.9),
and VLNT+LVB (2.8 days ± 0.3) did not differ significantly (p=0.20). Operative time for LVB (305.4 min ± 186.7), VLNT (254 min ± 164.4) and VLNT+LVB (295.3 min ± 43.2) was not significantly different (p=0.21)

Conclusions
Our analysis of the NSQIP data revealed that VLNT and LVB are procedures with no significant difference in perioperative morbidity. Our results support that choice of VLNT versus LVB can be justifiably made per the surgeon’s preference and experience as the operations have similar complication rates.

Introduction
Lymphedema is the chronic, progressive limb swelling caused by lymphatic dysfunction.\textsuperscript{1} An estimated 5 million Americans have this condition.\textsuperscript{2} Axillary node treatment for breast cancer is the most common etiology of lymphedema in the United States.\textsuperscript{3,4} Breast cancer related lymphedema develops in 30\% in patients who have undergone axillary lymph node dissection and up to 5-6\% in patients undergoing sentinel lymph node biopsy.\textsuperscript{4,5} Risk factors such as obesity, number of lymph nodes removed, use of chemoradiation regimen, breast reconstruction, and cellulitis have been identified.\textsuperscript{6-8}
Patients with breast cancer-related lymphedema exhibit arm swelling which progressively enlarges with the deposition of fluid, adipose and fibrosis.\textsuperscript{9-12} Currently there is no cure for lymphedema. Lymphedema can be managed conservatively with static compression, pneumatic compression, and complete decongestive therapy.\textsuperscript{13} Operative treatment includes excisional (skin/subcutaneous resection, liposuction) and physiologic procedures vascularized lymph node transfer (VLNT) and lymphovenous bypass (LVB).\textsuperscript{14-24} VLNT and LVB are both microsurgical physiologic procedures performed to enhance lymph transit in the affected extremity.\textsuperscript{17}

Improvement in limb volume and patient-reported outcomes have been described\textsuperscript{16,25-28} There is no consensus on timing of treatment, preferred operation, or the order of interventions between VLNT and LVB\textsuperscript{29}. Some surgeons prefer LVB initially based on the indocyanine green lymphangiography flow pattern while others prefer VLNT or a combination.\textsuperscript{30-32} The procedures are technically quite different. VLNT is a free tissue transfer requiring lymph node flap harvest and recipient vessels. LVB involves skin incision and anastomoses in the subcutaneous tissues. A systematic review of the literature has shown an approximately 30\% limb reduction following either procedure.\textsuperscript{16} Given these techniques are relatively new, there is limited data comparing the two procedures. Assessing morbidity of VLNT and LVB may help guide use as the preferred initial operation. The purpose of this study was to assess 30-day outcomes of VLNT and LVB for the treatment of breast cancer-related lymphedema using the National Surgical Quality Improvement Program (NSQIP) database.

The National Surgical Quality Improvement Program (NSQIP) database contains intraoperative and perioperative data on adult patients undergoing surgical procedures across all surgical disciplines. NSQIP data is collected at over 570 participating centers. NSQIP data-collection
methods have previously been described and validated.\textsuperscript{33,34} Trained reviewers at centers that collect data for the NSQIP database record 240 preoperative and intraoperative variables for each patient enrolled and any complications occurring in the first 30 days after surgery.\textsuperscript{35-46} Follow-up is ensured through appropriate means including chart review, phone calls, and follow-up visits. A recent audit of NSQIP data was found to have high inter-rater reliability with low discordance rates that have fallen over time.\textsuperscript{33}

**Methods**

We conducted a retrospective cohort study based on the NSQIP database in adults undergoing lymphatic physiologic procedures from 2012-2018. NSQIP data was queried for international classification of disease (ICD) for “postmastectomy lymphedema syndrome” (ICD-9 457.0, ICD-10 I97.2). Other codes for lymphedema were excluded to maximize subject homogeneity. Specific current Procedural Technology (CPT) codes do not exist for VLNT or LVB. Therefore, codes for free flap (15756, 15757, 15758), free omentum (49906) and free jejunum (43496) were used for VLNT; CPT 35206 (repair of upper extremity vessel) for LVB. Exclusion criteria included any patients not meeting the strict criteria noted above. Non-specific codes including 38308 (lymphangiotomy other) and 38999 (unlisted lymphatic procedure) were excluded because of lack of database clarity. The codes for 38999 (unlisted lymphatic procedure) and use of operating microscope could also be used to identify lymphatic procedures, but these were not included in our study to avoid capture of prophylactic lymphatic procedures.
Patients were grouped by the type of procedure that was performed: Group I: LVB, Group II VLNT, and Group III patients who had procedures simultaneously (VLNT+LVB). Patient characteristics were assessed including age, tobacco use, steroid use, American Society of Anesthesiologist (ASA) class, and medical comorbidities (e.g., diabetes, hypertension, renal failure, and chronic pulmonary disease). Primary outcomes assessed were postoperative length of stay, operative time, and perioperative complications including superficial surgical site infection (SSI), deep SSI, wound dehiscence, pneumonia, pulmonary embolism, cardiac arrest, sepsis, deep vein thromboembolism (DVT), and unplanned reoperation.

Statistical Analysis

All analyses were performed within SPSS Statistics version 19 (IBM Corporation, Chicago, IL). Comparative statistics including student’s t tests, one-way analysis of variance (ANOVA), chi-squared tests, and Fisher Exact tests. Two-tailed values of $P < 0.05$ were considered significant. Data are presented with means $\pm$ standard deviation where appropriate. A post hoc power analysis was conducted to estimate the power to detect the observed differences in postoperative complication rates between the treatment groups. The sample size of 145 in the VLNT group, 43 in the LVB group, and 11 in the VLNT/LVB group with complication rates of 9%, 2.3%, and 0% respectively provides 24.8% power to detect the differences between the groups.

Results

The study included 199 patients who had LVB (n=43), VLNT (n=145), or VLNT+LVB (n=11). The average age of all subjects was $55.1 \pm 10.4$ years. All patients were female (n=199), and the average BMI was $30.3 \pm 7.4$ with 45.7% (n=91) being obese (BMI>30). Most patients were
ASA classification 2 (48.7%) or ASA classification 3 (44.7%). The most common medical comorbidities were hypertension (33.2%) and diabetes mellitus (13.1%). Active smoking was recorded in a minority of patients (3.5%) (Table 1).

The average operative time for all lymphatic procedures was 267.5 ± 176.9 minutes. All procedures were performed under general anesthesia. The average postoperative length of stay was 2.3 days (standard deviation 2.2 days, range 0-13). Complications included wound dehiscence (0.5%), cardiac arrest (0.5%), and readmission (0.5%). Unplanned reoperation occurred in 5.5% of patients (n=11) (Table 2).

There was no difference in any co-morbidities between the groups (p=0.26) (Table 3). Thirty-day complication rates including unplanned reoperation (6.9% VLNT versus 2.3% LVB) and readmission (0.69% VLNT versus none in LVB) were not significant (p=0.54). Surgical site infection, wound complications, deep vein thromboembolism, and cardiac arrest was also similar among the three groups. Postoperative length of stay for VLNT (2.5 days, ± 2.3 days), LVB (1.9 days, ± 2.0 days), and VLNT+LVB (2.8 days, ± 0.3 days) also did not differ significantly (p=0.20). Operative time for LVB (305.4 minutes, ± 186.7 minutes), VLNT (254 minutes, ± 179.1 minutes) and VLNT+LVB (295.3 minutes, ± 43.2 minutes) was not significantly different (p=0.21) (Table 4).

No significant difference in morbidity was found when comparing obese to non-obese patients (p=0.73) (Table 5). Operative time for obese patients was 279.8 minutes (± 188.7 minutes).
compared to 257.1 minutes (± 166.6 minutes) in non-obese patients (p=0.37). The average length of stay was also similar between the two groups (p=0.73).

**Discussion**

LVB and VLNT are becoming more commonly performed for managing lymphedema. Both procedures have shown favorable clinical improvements in treating lymphedema in case series and systematic review of the literature.\textsuperscript{16,31,47,48} However, data is limited comparing morbidity in two procedures directly in order to determine which procedure is preferred. VLNT requires flap dissection for the harvest of the donor nodes (e.g. right gastroepiploic/omentum, supraclavicular, jejunum, groin, deep inferior epigastric artery nodes).\textsuperscript{20,49-51} Recipient vessels in the affected extremity (e.g, medial sural artery, radial artery) need to be procured.\textsuperscript{52,53} An arterial anastomosis and at least 1-2 venous anastomosis are performed and the flap is buried or or skin grafted.\textsuperscript{53} LVB only requires skin incisions in the affected extremity, localization of the small, sub-millimeter subcutaneous lymphatic vessels and venules, and lymphovenous anastomoses.\textsuperscript{17,21,54} Dissection is minimal and there is no donor site. LVB can be performed with different techniques such as end-to-end anastomosis or telescoping lymphatics into veins if size mismatch exists. An end-to-end anastomosis results in a more traditional vascular anastomosis and lumen patency can be easily assessed. It is more time consuming per anastomosis. Telescoping lymphatic vessels into a large vein can give multiple more lymphovenous connections per vein.

Despite the differences in the techniques, our study found no differences in 30-day complication rates between LVB and VLNT. The outcomes measured included unplanned reoperation, readmission, surgical site infection, wound complications, DVT, and cardiac arrest were all
statistically similar in both groups. Additionally, quality measures such as length of stay and operative time were also statistically similar. These findings show that both procedures can be safely performed with comparative 30-day outcomes. Our data suggests then that the choice to perform VLNT versus LVB can be made based on surgeon preference and experience.

Vascularized lymph node transfer surgery was the most common procedure performed. Not surprisingly, the combination LVB and VLNT was the least common, which is likely due to its recent adoption.\textsuperscript{48} Complication rates in LVB, VLNT, and LVB + VLNT were low, including infection rates. Reoperation and readmission rates were higher for VLNT, but this did not reach statistical significance. Length of stay was similar for all three procedures. However, LVB can be performed as an outpatient procedure as per our practice unlike VLNT. Interestingly, there were no differences in complication rates in obese patients compared to those not obese. Our study found similarly low complication rates as previously published studies.\textsuperscript{17,19,20,55-58} However, most studies on lymphatic procedures are focused on outcomes specific to lymphedema rather than complications such as those tracked by NSQIP. Overall, lymphatic procedures have low 30-day complication rates and are well tolerated by patients.

NSQIP is a large national database. Data entry is performed across hospitals throughout the country. Therefore, obtaining homogenous data can be challenging with NSQIP. The ICD-9 and ICD-10 codes for post-mastectomy lymphedema were used for patient selection criteria. This excluded other cancer related lymphedema such as melanoma for which VLNT and LVB are performed. However, ICD-10 codes for lymphedema are also variable and can be imprecise. Breast cancer-related lymphedema is the most common cause of lymphedema in the United
States. The “post-mastectomy lymphedema” ICD-10 code is specific for this type of lymphedema and was therefore selected. Including other etiologies of lymphedema in the study may have increased the total number of patients and therefore the statistical power to detect differences between the groups. In addition, CPT codes are not specific for VLNT and LVB. Excluding nonspecific codes for “lymphangiotomy” and “unlisted lymphatic procedure” also limited the number of subjects but resulted in greater homogeneity in the study.

Our study has several limitations. Primarily, the study was restricted to the data provided by NSQIP which includes 30-day complication rates. The effectiveness of the procedures was not able to be studied and neither were details of the operation. Clinical results of VLNT and LVB usually take greater than 30 days. The complications tracked by NSQIP are generally uncommon in procedures such as VLNT and LVB, and therefore, complication rates reported were low. Our study was limited by the data available in NSQIP, which is general postoperative complications, not specific to VLNT or LVB. Ideally, we would have collected data such as stages of lymphedema, postoperative protocols, outcomes of surgical treatment, improvement of lymphedema, and improvement of life quality, but this was not possible with the NSQIP database. A powerful outcome to measure after lymphatic surgery is improvement of quality of life59, but unfortunately, this is not possible with the NSQIP database. Additionally, we were limited by the lower numbers of cases in NSQIP of lymphatic surgery with our strict inclusion criteria based on narrow ICD-10 and CPT codes to maximize homogeneity of the data. Given this study was underpowered due to the small number of patients, this introduces the potential for a type II error, and thus, our findings serve as preliminary evidence when comparing the types of
lymphatic procedures available for lymphedema. The type of LVB (e.g., end-to-end anastomosis or telescopic technique) could not be deciphered as they do not have distinct CPT codes.

In conclusion, our analysis of the NSQIP data revealed that VLNT and LVBs have no significant difference in 30-day perioperative morbidity. This large database study did not provide insight to efficacy of the procedures. However, our results support that choice of VLNT versus LVB can be justifiably made per the surgeon’s personal preference and experience as the operations have similar complication rates.

References


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**Table 1.** Patient demographic information for all lymphatic procedures
Table 2. Patient outcome data for all lymphatic procedures

Table 3. Patient demographic information for Vascularized Lymph Node Transfer (VLNT), Lymphovenous Anastomosis (LVB), and combination VLNT and LVB.

Table 4. Patient outcome data for Vascularized Lymph Node Transfer (VLNT), Lymphovenous Anastomosis (LVB), and combination VLNT and LVB.

Table 5. Patient outcome data for non-obese versus obese patients