

A non-randomized retrospective observational study on the subcutaneous esophageal reconstruction after esophagectomy: is it feasible in high-risk patients?

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Background: Esophageal reconstruction after esophagectomy is a complex procedure with high morbidity and mortality. Anastomotic leakage is more severe and frequent in patients with preoperative comorbidities and may present with septic conditions. Considering the possibility of an easier management of such cases, we evaluated the safety and feasibility of subcutaneous esophageal reconstruction in patients with high operative risks.

Methods: We performed a non-randomized retrospective observational study on the 75 (subcutaneous: 21, intrathoracic: 54) esophageal cancer patients who underwent esophageal reconstruction either through subcutaneous or intrathoracic route between January 2003 and February 2015. Preoperative data including the estimated reasons for the selection of the subcutaneous route were obtained from medical charts. Clinical outcomes were evaluated and compared between the two groups.

Results: The mean postoperative hospital stay was longer in the subcutaneous group than the overall group. Anastomotic leakage occurred more frequently in the subcutaneous group [10 (47.6%) vs. 7 (13%), $P=0.004$]. Three major leakages resulted in chronic cutaneous fistula, but were successfully treated by lower neck reconstruction using radial forearm fasciocutaneous free flap (RFFF). There was no in-hospital mortality in the subcutaneous group.

Conclusions: Subcutaneous esophageal reconstruction in high-risk patients showed a higher rate of anastomotic leakage. However, easier correction without fatal septic conditions could be obtained by primary repair or flap reconstruction resulting in lower perioperative mortality. Therefore, esophageal reconstruction through the subcutaneous route is not recommended as a routine primary option. However, in highly selected patients with unfavorable preoperative comorbidities or intraoperative findings, especially those with poor blood supply to the graft, graft hematoma or edema, or gross tumor invasion to surrounding tissues, esophageal reconstruction through the subcutaneous route may carefully be considered as an alternative to the conventional surgical techniques.

Keywords: Anastomotic leakage; comorbidities; esophageal reconstruction; subcutaneous route

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Introduction

Esophagectomy and esophageal reconstruction is a complex invasive procedure with high morbidity (40%) and mortality (5–10%) rates (1,2). According to previous studies, the presence of comorbidities such as old age, hypertension, diabetes, smoking status, congestive heart failure, coronary artery disease, poor preoperative pulmonary function, and high preoperative serum creatinine level worsens the clinical outcomes including anastomotic leakage, pulmonary complications, and overall survival (2-7). Therefore, additional consideration for lowering the operative morbidity and mortality is required for those patients with comorbidities.

Among the multiple options for the placement of the conduit during esophageal reconstruction, the posterior mediastinal route is most commonly used because of its lower rates of postoperative morbidity and mortality compared to other routes (8,9). On the other hand, esophageal reconstruction through the subcutaneous route is rarely performed as a primary surgical strategy because of its poor cosmetic appearance. It is usually considered as an option only after failure of previous esophageal reconstruction (10-12).

The reported rates of anastomotic leakage after cervical anastomosis are between 9% and 25% (13,14). Most cases of anastomotic leakage are easily controlled by simple drainage and conservative managements. However, while some cases may be asymptomatic or present with only local signs, other cases may present with respiratory symptoms due to pleural or mediastinal collections, or systemic septic conditions secondary to gastric necrosis (14,15). Major cervical anastomotic leakage, including that combined with graft necrosis, is considered an important predictor of subsequent death (15). Additionally, cervical anastomotic leakage may prolong hospital stay and lead to other complications (13).

The extrathoracic placement of the anastomosis site and the conduit graft in the subcutaneous esophageal reconstruction may prevent the leakage to the mediastinum or pleural cavity in case of anastomotic leakage, and thereby decrease the possibility of severe infection. Furthermore, prompt diagnosis of the graft status and easier correction of the leakage site may be possible because of the closer placement of the graft to the skin. In this aspect, we assumed that it may be a more conservative and safe method for avoiding disastrous conditions after esophageal reconstruction, especially in patients with comorbidities who may have a higher risk of postoperative anastomotic

leakage and pulmonary complications.

Thus, to evaluate the safety and feasibility of esophageal reconstruction through the subcutaneous route, we analyzed the perioperative outcomes including the postoperative complications such as anastomotic leakages and also the patients' postoperative clinical progression.

Methods

This was a retrospective, observational study of patients who underwent esophageal reconstruction through the subcutaneous route at Korea University Medical Center between February 2004 and May 2015. The Institutional Review Board of Korea University Medical Center approved this study (No. AN16343-001).

Inclusion and exclusion criteria

All patients diagnosed as having esophageal cancer and treated with esophageal reconstruction with cervical anastomosis through the subcutaneous route were included in our study. The selection criteria for the use of subcutaneous route were based on the surgeon's choice depending on the presence of major preoperative comorbidities and the intraoperative findings. Preoperative comorbidities are described in *Table 1*. Past history of uncontrolled hypertension or diabetes, patient noncompliance including chronic alcoholic abuse, heavy smoking, and intraoperative findings such as poor graft blood supply, poor graft color, and extensive tumor invasion requiring postoperative radiotherapy were the main reasons for deciding to perform the esophageal reconstruction through the subcutaneous route.

Only patients who had esophageal reconstruction through the subcutaneous route as their first operation were included and those who had it after a failure of previous attempt of esophageal reconstruction were excluded from our study considering the possibility of other implications on the outcomes.

Surgical procedure and perioperative care

For subcutaneous esophageal reconstruction, standard esophagectomy and abdominal mobilization of stomach or colon graft through the laparotomy was performed. Then, a left oblique cervical incision along the anterior border of the sternocleidomastoid muscle of about 8 cm with slight extension to the upper manubrium level was

Table 1 Preoperative comorbidities of the subcutaneous group compared to the overall esophageal reconstruction patients in our department

Comorbidities	Subcutaneous group (%)	Overall group (%)	P value
Hypertension	12 (57.1)	18 (33.3)	0.059
Diabetes	5 (23.8)	10 (18.5)	0.749
Atrial fibrillation	4 (19.0)	3 (5.6)	0.091
Angina	2 (9.5)	1 (1.9)	0.188
Heart failure	1 (4.8)	2 (3.7)	1.000
Liver cirrhosis	3 (14.3)	2 (3.7)	0.130
Kidney disease (AKI/CKD/nephrectomy)	5 (23.8)	2 (3.7)	0.016
Stroke	2 (9.5)	0	0.076
Psychological disorder (dementia)	2 (9.5)	1 (1.9)	0.188
COPD/emphysema/asthma	5 (23.8)	6 (11.1)	0.273
Pulmonary infectious disease (pneumonia/tuberculosis)	8 (38.1)	11 (20.4)	0.113
Chronic alcoholic	8 (38.1)	11 (20.4)	0.113
Heavy smoker	10 (47.6)	6 (11.1)	0.001
Other cancer	6 (28.6)	7 (13.0)	0.171
Old age (>75 years)	4 (19.0)	2 (3.7)	0.048
Negative intraoperative findings	8 (38.1)	14 (25.9)	0.398

AKI, acute kidney injury; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease.

performed. The subcutaneous layer between the cervical and laparotomy incision was dissected with extreme caution not to miss any bleeding and also for an even dissection to prevent any possibility of skin necrosis. When a subcutaneous dissection of about 5 cm width was obtained, which enables a tension-free movement of the graft, the graft was pulled up through the subcutaneous route until the upper portion of graft reached the cervical opening where the esophagogastrostomy is later performed. The usual esophageal reconstruction through the posteromediastinal or retrosternal route was performed just like in the subcutaneous route, except that the conduit is passed through the intrathoracic routes. All patients were admitted in the intensive care unit (ICU) for the immediate postoperative period. Cervical anastomosis was monitored clinically, and oral diet was started between the 7th and 14th day postoperatively after confirmation by contrast radiography. The postoperative patients were followed up routinely between 1 and 2 weeks after discharge, 6 months, and yearly postoperatively at the out-patient

clinic. And examinations were based on physical examination, esophagogastroduodenoscopy, and chest computed tomography.

Outcome measurements

Patient characteristics such as age, sex, tumor location, grade, histology, and preoperative comorbidities were analyzed. Data on the surgery technique and substitute organ used for reconstruction were obtained retrospectively from medical charts. Additionally, reasons for the application of esophageal reconstruction through the subcutaneous route were also analyzed and evaluated.

To analyze the clinical outcomes, postoperative complications, reoperation, 30 days in-hospital mortality, operative time, length of hospital stay, and ICU stay were evaluated. To evaluate the relative advantages and disadvantages of the subcutaneous technique, we compared the results with our overall results from the posteromediastinal and substernal routes.

Statistics

All data were entered into an Excel spreadsheet (Microsoft, Bellevue, WA, USA). Data were analyzed using IBM SPSS Statistics Version 20 (IBM SPSS Software, Armonk, NY, USA) to determine the perioperative clinical outcomes. Univariate data analysis included *t*-tests for continuous numerical variables, and Chi-square and Fisher's exact test for discrete categorical variables. Multivariate analysis included logistic regression. Data are reported as the mean \pm standard error of the mean. A *P* value <0.05 was considered statistically significant.

Results

A total of 21 patients were included in this study. All patients underwent esophageal reconstruction with cervical anastomosis through the subcutaneous route. Preoperative patient characteristics including age, sex, pathology, tumor location, TNM staging, and additional surgical factors are described in *Table 2*.

The main reason for the selection of the subcutaneous route was the surgeon's decision considering the intraoperative findings (8/21, 38.1%). Among the 8 patients, the subcutaneous route was selected in 4 (50%) patients because of the poor graft status including edema or unsatisfying color, or concurrent mucosal resection of early gastric cancer with a higher risk of postoperative anastomotic leakages. In the other 4 patients, the subcutaneous route was selected because of extensive tumor progression with suspicious invasion to surrounding tissues such as the main bronchus or enlarged lymph nodes probably requiring postoperative radiotherapy. The rest of the patients (13/21, 61.9%) had serious risk factors such as old age (>70 years), chronic kidney disease, chronic alcoholism with liver cirrhosis, heavy current smokers with emphysematous lung, or stroke history. The mean Charlson comorbidity index score of the subcutaneous group was 6.29 ± 2.12 .

The mean operative time was 387.71 ± 93.60 minutes, and the mean hospital stay was 55.57 ± 55.93 days (*Table 3*). Among the 21 patients, 13 (61.9%) patients were extubated in the operating room and the other seven (33.3%) patients were extubated on postoperative day 1 without any complication. Only one (4.8%) patient had to go through prolonged ventilation for 7 days in the ICU because of poor pulmonary function. There was no early postoperative in-hospital mortality.

There were 14 (66.7%) patients with postoperative

complications (*Table 4*). Anastomotic leakage (10 cases, 47.6%) was one of the main problems. Three (14.3%) of the anastomotic leakages were major and resulted in chronic cutaneous fistula, requiring lower neck reconstruction using a pectoralis muscle flap and radial forearm fasciocutaneous free flap (RFFF) coverage. The other 7 (33.3%) were minor leakages, among which 5 (23.8%) required reoperation with simple primary repair, and 2 (9.5%) were resolved by spontaneous wound healing after a certain time.

The mean follow up period of the subcutaneous group was 25.5 ± 26.06 months. Regarding the chronic complications, 9 patients (42.9%) developed chronic complications including 3 (14.3%) cases of esophageal stricture requiring endoscopic balloon dilatation, 2 (9.5%) cases of pneumonia treated with antibiotics, 2 (9.5%) cases of mild dysphagia, 1 (4.8%) case of esophagocutaneous fistula treated with RFFF coverage, and 1 (4.8%) case of vocal cord palsy due to tumor recurrence at the subaortic lymph node which was treated with injection laryngoplasty.

Discussion

Despite favorable trends toward reduced incidence and morbidity of esophageal leaks, esophagogastric anastomotic failure with a reported prevalence of 0.57–53% remains an important source of postoperative morbidity and mortality (16,17). Preoperative comorbidities such as hypertension, diabetes, serum levels of creatinine, old age (>75 years), congestive heart failure, coronary artery disease, peripheral vascular disease, renal insufficiency, and heavy smoking were reported to be strong predictors of major morbidity after esophagectomy (2,5,6). Therefore, when planning for esophagectomy and reconstruction for patients with comorbidities, careful attention should be paid to the possibility of anastomotic failure.

There are multiple options for the placement of the gastric or colon conduit. Among them, the retrosternal and posterior mediastinal route are the most commonly used for the reconstruction after esophagectomy (9). In our study, we focused on patients who had esophageal reconstruction through the subcutaneous route. The main reasons for the selection of the subcutaneous route were the intraoperative findings such as poor blood supply, unsatisfactory graft color, edematous change of the graft, and preoperative comorbidities such as old age (>70 years), hypertension, diabetes, heavy current smoking with emphysematous lung, chronic alcohol abuse with liver cirrhosis, chronic kidney disease, or stroke histories (*Table 1*). Our decisions were

Table 2 Patient characteristics

Variable	Subcutaneous group (%)	Intrathoracic group (%)	P value
Total	21	54	
Age	69.52±6.86	61.56±7.61	<0.001
Sex			0.054
Male	21 (100.0)	45 (83.3)	
Female	0	9 (16.7)	
Tumor location			0.162
Upper	0	3 (5.6)	
Mid	16 (76.2)	29 (53.7)	
Lower	5 (23.8)	22 (40.7)	
Pathology			–
Squamous cell carcinoma	21 (100.0)	54 (100.0)	
Adenocarcinoma	0	0	
T stage ^a			0.136
T1	6 (28.6)	20 (37.0)	
T2	2 (9.5)	10 (18.5)	
T3	13 (61.9)	19 (35.2)	
T4	0	5 (9.3)	
N stage ^b			0.545
N0	14 (66.7)	37 (68.5)	
N1	5 (23.8)	10 (18.5)	
N2	2 (9.5)	3 (5.6)	
N3	0	4 (7.4)	
Approach for esophagectomy			0.867
VATS	12 (57.1)	32 (59.3)	
Transhiatal	6 (28.6)	6 (11.1)	
Open thoracotomy	3 (14.3)	16 (29.6)	
Graft			0.311
Stomach	19 (90.5)	52 (96.3)	
Colon	2 (9.5)	2 (3.7)	
Complete resection			0.537
R0	20 (95.2)	49(90.7)	
R1	1 (4.8)	2(3.7)	
R2	0	3(5.6)	
Dissected lymph nodes			–
Total number	17.05±11.89	15.26±10.41	0.684
Positive for malignancy	0.90±1.58	0.91±2.17	0.775

^a, tumor; ^b, node. VATS, video-assisted thoracoscopic surgery.

Table 3 Postoperative results of the esophageal reconstruction through the subcutaneous route

Variables	Subcutaneous group (%)	Intrathoracic group (%)	P value
Operative time (min)	387.71±93.60	366.35±84.81	0.247
Time to extubation (day)	0.67±1.53	0.44±2.06	0.056
ICU stay (day)	2.43±2.69	5.04±18.56	0.038
Hospital stay (day)	55.57±55.93	28.04±29.50	0.003
Follow up period (day)	577.57±563	1122.26±1028	0.029
Postoperative complications	14 (66.7)	24 (55.6)	0.084
Chronic complications	9 (42.9)	8 (14.8)	0.014
Reoperation	11 (52.4)	6 (11.1)	<0.001

ICU, intensive care unit.

Table 4 Postoperative complications

Complications	Subcutaneous group (%)	Intrathoracic group (%)	P value
Total	14 (66.7)	24 (55.6)	0.084
Anastomotic leakage	10 (47.6)	7 (13.0)	0.004
Major	3	2	
Minor	7	5	
Esophageal stricture	3 (14.3)	4 (7.4)	0.392
Graft necrosis	1 (4.8)	3 (5.6)	1.000
Pneumonia	3 (14.3)	4 (7.4)	0.392
Postoperative bleeding	1 (4.8)	1 (1.9)	0.484
Vocal cord palsy	2 (9.5)	4 (7.4)	1.000
Prolonged ventilation	1 (4.8)	2 (3.7)	1.000
Chylothorax	0	2 (3.7)	1.000
Wound infection	2 (9.5)	3 (5.6)	0.615
Arrhythmia	0	4 (7.4)	0.571

based on the idea that such preoperative and intraoperative findings may act as the risk factors for major morbidities including anastomotic leakages as reported in many previous studies (2,5,6). Therefore, we assumed that this rather less cosmetic and unorthodox method could be more appropriate for high-risk patients in terms of perioperative safety.

The incidence of postoperative anastomotic leakage in our subcutaneous group was 47.6% (10/21 cases). Even though the results coincide with our expectation of higher

anastomotic failure in patients with comorbidities, it is still quite unsatisfactory when compared to the results of other previously reported studies (5,13,17,18), or even when compared to the overall anastomotic leakage rate in our department (7/54, 13%, P=0.004). After an analysis of the risk factors between the subcutaneous group and the rest of the patients operated in our department, we have concluded that several factors may have been associated with the high rate of anastomotic failure in the subcutaneous group. First, all patients included in this

Table 5 Multivariate analysis of preoperative risk factors that may be associated with postoperative complications

Outcome	Predictor variable	Regression coefficient	OR (95% CI)	P value
Risk of postoperative complications	Negative intraoperative findings	2.351	10.500 (1.015–108.577)	0.049
Risk of anastomotic leakage	History of pneumonia or pulmonary tuberculosis	2.015	7.500 (1.023–54.996)	0.047

Negative intraoperative findings such as poor graft color or edema and extensive tumor progression were found to be significant risk factors for postoperative complications. Previous history of pneumonia or pulmonary tuberculosis was also a significant risk factor for anastomotic leakage. CI, confidence interval; OR, odds ratio.

study were high-risk patients with at least more than one major preoperative comorbidity, probably increasing the possibility of anastomotic leakage and other postoperative complications. A significantly higher proportion of patients with hypertension, heavy smoking, kidney disease, and old age were included in the subcutaneous group compared with the overall esophageal reconstruction patients in our department who had esophageal reconstruction through the intrathoracic route (*Table 1*). Since the above factors are considered as main risk factors for increasing postoperative comorbidities, this may explain the higher anastomotic leakage rate in our subcutaneous group. When we applied the multivariate logistic regression to the results, the negative intraoperative findings such as poor blood supply to the graft, graft hematoma or edema, and gross tumor invasion to surrounding tissues acted as an independent predictor of overall postoperative complications, while previous history of pneumonia or pulmonary tuberculosis acted as an independent predictor of anastomotic leakage as summarized in *Table 5*. Second, the cervical anastomosis itself which is considered an important risk factor for increasing the anastomotic leakage rate (14,19), together with the longer distance of the subcutaneous route compared to the posteromediastinal and retrosternal route may have also affected the results. As a result, esophageal reconstruction with cervical anastomosis through the subcutaneous route seems to result in higher anastomotic failures. The higher postoperative leakage rate also increased the duration of hospital stay (55.57 ± 55.93 days), which is significantly longer than the overall hospital stay of the esophageal reconstruction patients in our department (28.04 ± 29.50 days, $P=0.003$).

The anastomotic leakages vary in magnitude, and the treatment strategy depends on the severity of the leakage. Previous reports have shown conflicting results regarding the impact of anastomotic leakage on the in-hospital

mortality, which seems to depend on the location of the anastomosis. Rutegard *et al.* reported that the postoperative death rate following intrathoracic anastomotic leakage increased by 3-fold when compared to that without such complication (17). On the other hand, Aminian *et al.* reported that cervical leakage is not associated with mortality (2). Moreover, the fatality rate from major esophageal leaks was reported to be between 21–35% in many studies (15,20). While some anastomotic leakages can be treated conservatively, others may require immediate reoperation for graft removal and secondary reconstruction (17). Considering the poor nutritional status and the preoperative comorbidities of patients with postoperative anastomotic leakage, they may not be in proper conditions for tolerating additional major reoperations. Furthermore, even though the patients may tolerate the reoperation, such major reoperations may result in increased perioperative risks. So, performing a major reoperation after anastomotic leakage following esophageal reconstruction is quite a challenge not only for the patient but also for the surgeon.

Despite its higher leakage rate, the esophageal reconstruction through the subcutaneous route may have some minor advantages in some aspects. One of the advantages of esophagogastrostomy through the subcutaneous route is that the postoperative monitoring and management of the anastomotic leakage is quite simple and less burdensome to both the patient and the surgeon when compared to the cervical esophagogastrostomy via intrathoracic route. The anastomosis and graft status can be monitored easily postoperatively just by observing and palpating the cervical wound and the subcutaneously tunneled area of the anterior chest wall. If there is any sign of leakage, it can be drained very easily through the cervical wound preventing any further progress of infection. There were 10 patients with cervical anastomotic leakage in our study, but no patient showed any sign or symptom of mediastinitis or sepsis.



Figure 1 Postoperative cutaneous fistula caused by the anastomosis leakage after subcutaneous esophageal reconstruction.



Figure 2 Postoperative wound of a RFFF performed at the cutaneous fistula. RFFF, radial forearm fasciocutaneous free flap.

Consequently, this resulted in zero in-hospital mortality related to postoperative anastomotic leakage. Among the 10 leakage patients, 7 had minor leakages of which 2 were resolved spontaneously just by additionally restraining the oral intake. Five patients required reoperation because of failure of spontaneous healing. However, even in

those patients, the exploration of the leakage site and confirmation of the graft status through the cervical wound were very easy when compared with the leaks following the Ivor-Lewis operation or cervical esophagogastrostomy through the posterior mediastinal route, because of the more superficial location of the anastomosis site. After confirmation of the viable tissues including mucosa near the leakage site and the graft status through the cervical wound, the leaks could be managed with a simple interrupted suture repair. This way, the reoperation could be performed in a short operative time and did not require either one-lung ventilation, thoracotomy, or laparotomy which could be a burden to the already weakened patients. As for the result, all five patients were discharged showing sufficient oral intake without any additional complications.

The advantage of subcutaneous esophageal reconstruction was even more remarkable when dealing with the major leakage complications. In the subcutaneous group, there were three patients with major anastomotic leakage which resulted in chronic cutaneous fistula (*Figure 1*). Unlike the cases of conduit necrosis in the intrathoracic route, we could examine the status of the gastric conduit more easily by exploring the neck wound including the upper anterior chest wall. In all three patients, only the small upper portion of the graft near the anastomosis site was necrotic, and the rest of the graft including the mucosa was viable. Therefore, instead of graft take down and reconstruction using a colon or jejunum graft, debridement of the necrotic site and coverage of the cutaneous fistula at the lower neck using a pectoralis major muscle or RFFF was performed after about 5 to 6 weeks after the esophagectomy (*Figures 2,3*). All three patients recovered and were discharged with sufficient oral intake without any additional major complications.

Our study has several limitations. First, this study is limited by its retrospective nature and data based on medical chart reviews. Moreover, the heterogeneous preoperative characteristics including the comorbidities between the subcutaneous group and the rest of our patients may have affected both the acute and chronic postoperative progression of the patients, preventing any possibility of direct comparison between the subcutaneous group and the overall results from the rest of our patients. Also, considering that the subcutaneous group had relatively more risk factors, it would be hard to conclude that the high leakage rate resulted mainly due to the subcutaneous reconstruction. Finally, our study included only a small number of cases; therefore, our findings should

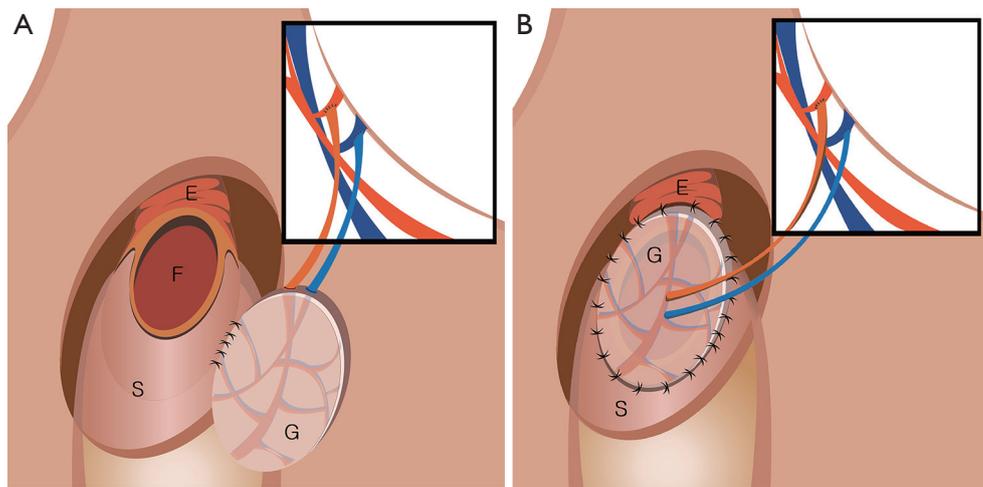


Figure 3 Schematic picture of a RFFF performed at the cutaneous fistula of the anastomotic leakage site. With careful measurement of the lengths of the grafts, radial artery and venacommittant were prepared. Radial artery was anastomosed to the superior thyroidal artery in end-to-end fashion with interrupted sutures of nylon 9-0. Venacommittant of radial artery was anastomosed to the superior thyroidal vein in end-to-end fashion using the coupler 2.0. And, finally they were fixed with fibrin glue to avoid kinking of the anastomosed grafts. (A) Area of fistula at the esophagogastric anastomosis site exposed before coverage by the RFFF procedure; (B) final status after performing the coverage of fistula using the RFFF procedure. RFFF, radial forearm fasciocutaneous free flap.

be interpreted with caution as the generalizability of our results is limited. Further studies with a larger sample size are warranted to confirm the safety and effectiveness of the subcutaneous route in esophageal reconstruction surgery.

In conclusion, patients with serious comorbidities who underwent esophageal reconstruction through the subcutaneous route showed a higher rate of postoperative anastomotic leakages and a longer hospital stay when compared to the overall esophageal reconstruction patients. Given the high anastomotic leakage rate, we have to be careful in choosing the subcutaneous route. However, unlike the leakages from the grafts placed by the intrathoracic route, which may cause sepsis through mediastinitis or require a major reoperation with graft removal and reconstruction with another graft, an easier correction could be obtained by simple primary repair or flap reconstruction resulting in lower perioperative mortality. Therefore, considering the disadvantages such as poor cosmetic aspect and higher risk of anastomotic leakage, we do not recommend esophageal reconstruction through the subcutaneous route as a routine primary option. In highly selected patients with unfavorable preoperative comorbidities or intraoperative findings, especially those with poor blood supply to the graft, graft hematoma or edema, or gross tumor invasion to surrounding tissues, esophageal reconstruction through the subcutaneous

route may carefully be considered as an alternative to the conventional surgical techniques.

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Footnote

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

Ethical Statement: The Institutional Review Board of Korea University Medical Center approved this study (No. AN16343-001).

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