Functional Outcomes and Reevaluation of Esophageal Speech After Free Jejunal Transfer in Two Hundred Thirty-Six Cases

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Abstract: Swallowing and communication are occasionally impaired after free jejunal transfer. Here, the relationship between surgical procedure and functional outcome was analyzed in 236 patients undergoing free jejunal transfer after total laryngopharyngectomy from 1992 through 2003. Swallowing and communication functions were also investigated with a questionnaire in 40 long-surviving patients. Although oral feeding could be resumed after surgery in most patients, anastomotic stricture and nasal regurgitation occurred in 12.7% and 29.7% of patients, respectively. Use of our standardized procedure, the tensed jejunal method, significantly reduced the incidence of stricture ($P < 0.01$) but increased the rate of nasal regurgitation; however, in most cases regurgitation gradually resolved. Of the 40 long-surviving patients, 17 attended a speech rehabilitation program at which 12 learned to perform esophageal speech without voice restoration procedures (11 of the 12 had received a tensed jejunal graft). Our standardized procedure helps prevent strictures and encourages esophageal speech.

Key Words: esophageal speech, free jejunal transfer, swallowing function, stricture

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Free jejunal transfer (FJT) is the most common method of pharyngeal reconstruction after pharyngolaryngectomy because of its low incidence of complications.[1–13] Although FJT is a reliable procedure, functional problems remain, including dysphagia because of anastomotic stricture, and aphonia because of laryngectomy. A voice prosthesis for tracheoesophageal shunt or elephant trunk shunt can be used to restore phonation; however, aspiration can still occur.[4–9] Some studies have assessed functional outcomes after FJT, but few studies have examined swallowing function or esophageal speech.[4,5] Previously, we reviewed our FJT procedures and postoperative complications, but not enough about postoperative functions.[12] In the present study, we evaluated postoperative swallowing and speech functions to re-evaluate esophageal speech without the use of mechanical or prosthetic devices after FJT.

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PATIENTS AND METHODS

We reviewed all patients who had undergone FJT after pharyngolaryngectomy from 1992 through 2003 at the National Cancer Center Hospital East, Chiba, Japan. The 236 patients included 38 women and 198 men and had a mean age of 63.5 ± 8.9 years (standard deviation [SD]). Medical records were examined to analyze the following variables: patient history, type of surgery or defect, flap survival, postoperative complications, frequency of nasal regurgitation, presence of anastomotic stricture, the period of appearance or improvement of nasal regurgitation or dysphagia, number of times strictures were dilated, and oral intake ability. Multiple-choice questionnaires about swallowing and communication functions were administered during follow-up in 2004 and 2005 (Table 1). Esophageal speech was evaluated on the basis of its use as the primary means of communication.

Since 2000, we have used a standardized procedure, the tensed and straight jejunal method, for most patients undergoing reconstruction with FJT. In this method a section of the jejunum is harvested and an exteriorized monitoring flap is prefabricated. After the oral side of the jejunum is trimmed, pharyngojejunostomy is performed. Differences in caliber are adjusted by means of longitudinal incisions of the jejunum.[10–12] The anal side of the jejunum is trimmed so that the jejunal graft can be pulled straight after complete enteric anastomosis. When relaxed, the segment of jejunum was approximately two-thirds or one-half the length of the defect (Fig. 1). Until 1999, we used a variety of surgical procedures. Therefore, patients were divided into 2 groups: a nonstandardized procedure group, treated from 1992 through 1999, and a standardized procedure group, treated from 2000 through 2003. Most patients in the standardized procedure group had been treated with a single standardized procedure, whereas patients in the nonstandardized procedure group had been treated with a variety of surgical procedures, including the standardized procedure used after 1999.

The shape of pharyngeal defects was classified as either oblique or horizontal. The defect was defined as oblique if the tumor had spread to the lateral or posterior wall of the oropharynx and resected with oblique plane. The rest was classified as horizontal even if the tumor had spread to the nasopharynx.[11]

A barium swallow study was usually performed 1 or 2 weeks after FJT, and an oral feeding was started if no leaks were identified.

Statistical analysis was performed with a statistical software program (Statcel version 2, OMS Publishing, Saitama, Japan). Fisher exact test, the t test, and the χ^2 test were used. Statistical significance was indicated by a P value less than 0.05.

RESULTS

The primary site of cancer, which could be either a single primary cancer, 1 of 2 primary cancers, or a recurrent cancer, was the hypopharynx in 198 cases (83.9%), the larynx in 14 cases (5.9%), and the cervical esophagus in 24 cases (10.2%). Twenty patients (8.5%) had previously been treated for an earlier cancer. Fifty-nine patients (25.0%) had received irradiation to the neck, and 20 of these 59 patients (8.3%) had also undergone chemotherapy.

TABLE 1. Questionnaire for Patients

Question 1. How much time did you need to eat dinner?
Before operation: 10 20 30 40 50 more (minutes)
After operation: 10 20 30 40 50 more (minutes)
Question 2. Do you have nasal regurgitation when you eat?
1. Never
2. Sometimes
3. Frequently
Question 3. What do you use to communicate with others?
1. Pen and paper
2. Electrolarynx, sometimes use pen and paper
3. Electrolarynx only
4. Esophageal speech, sometimes with assistance
5. Esophageal speech only
Question 4. To whom can you make yourself understood?
1. Family only
2. Acquaintances
3. Unrelated persons
4. Acquaintances via telephone
5. Anyone via telephone, as before the operation

All patients underwent total pharyngolaryngectomy. Cervical lymph node dissection combined with internal jugular vein excision, which limits the number of possible recipient vessels, was performed in 53 patients (22.5%). In most patients the primary tumor had not extended cranially, and the type of defect was classified as horizontal. Defects were horizontal defects in 193 patients (81.8%) and oblique in 43 patients (18.2%). The posterior wall of the mesopharynx had been excised in 8 patients with oblique defects (18.6%; 3.4% of all cases). A total of 121 patients (51.3%; Table 2) were treated from 1992 through 1999 (nonstandardized procedure group) and 115 patients (48.7%) were treated from 2000 through 2003 (standardized procedure group).

Of the 236 patients 10 required reexploration, which showed that flaps were not salvageable in 5 of these patients. The overall success rate of FJT was 97.9%. In all patients with nonviable flaps, FJT was successfully performed a second time. Five patients died after surgery: the causes of death were acute renal failure (2 patients), brain infarction (1 patient), acute hepatic failure (1 patient), and myocardial infarction (1 patient). Oral feeding was not possible in 2 patients because of bilateral hypoglossal nerve palsy because of previous operations for other head and neck lesions. After these 2 patients and the 5 patients who died were excluded, the remaining 229 patients were reviewed in this study. However, fistula formation was seen in 21 patients (9.2%) and all 229 patients could resume oral feeding 6 to 103 days after surgery (mean, 13.6 days). Adjuvant radiation therapy was performed in 22 patients starting 14 to 37 days after surgery.

Nasal regurgitation was observed with oral feeding in 68 patients (29.7%). Of these 68 patients, 41 (60.3%) showed improvement without treatment 2 to 110 days after starting oral feeding. Nasal regurgitation was more frequent in the standardized procedure group ($P = 0.02$). Other factors, such as age, history of irradiation, and type of surgical defect, did not affect the rate of nasal regurgitation (Table 3). These factors also had no effect on whether nasal regurgitation showed improvement. There was no significant difference between the standardized procedure group and the nonstandardized procedure group with respect to the improvement in regurgitation. At the time of discharge, all patients could tolerate a normal or soft diet, despite the presence of nasal regurgitation.

Anastomotic stricture, defined as anatomic narrowing that compromised swallowing and required either endoscopic dilation or bougienage, developed at the esophagojejunal (distal) anastomosis in 29 patients (12.7%) who did not have tumor recurrence. History of irradiation and adjuvant radiation therapy did not affect the development of anastomotic stricture. Although mechanical anastomosis was performed in 10 patients (4.4%), the stricture rate was higher (70%; $P < 0.01$) than in other patients. In contrast, of the 111 patients of the standardized procedure group, only 7 (6.3%) had stricture ($P < 0.01$, Table 4). Symptoms of stricture appeared 6 to 1100 days after operation; strictures were treated by performing endoscopic dilation or bougienage 1 to 10 times. Neither the day when symptoms of stricture appeared nor the number of dilations performed was affected by a history of irradiation, the device of anastomosis, or the FJT procedure.

In 2004 and 2005, a questionnaire was distributed to 47 long-surviving patients during follow-up. Questionnaires were not distributed to the 189 remaining patients because of the need to treat recurrence, follow-up at other hospitals, or death. Questionnaires were completed by 40 patients (85.1%; including 6 patients in the nonstandardized procedure group and 34 patients in the standardized procedure group) at an average of 31 months of follow-up (range, 3–89 months; Table 5). Nasal regurgitation was reported to be absent by 16 patients (40%), occasional by 22 patients (55%), and

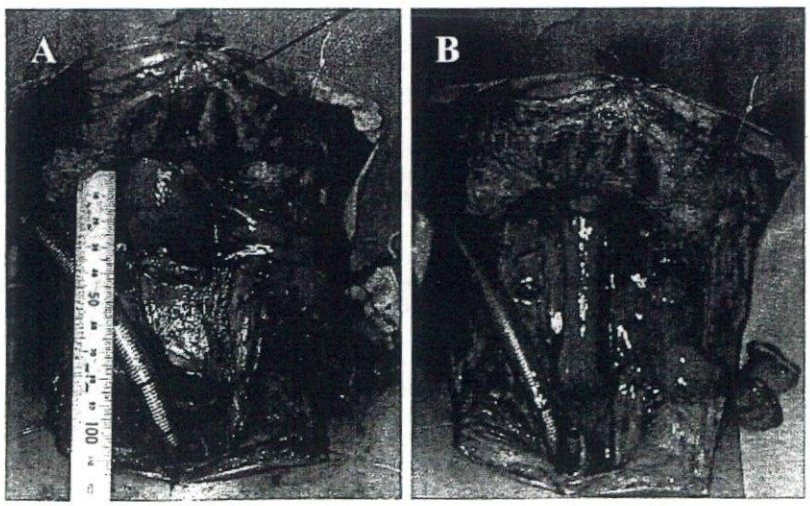

FIGURE 1. A, When relaxed, the segment of jejunum was approximately two-thirds or one-half the length of the defect. B, After complete enteric anastomosis, the jejunal graft could be pulled straight and tensed.

TABLE 2. Characteristics of Patient Groups and Differences in Surgical Procedures

	Nonstandardized Procedure Group	Standardized Procedure Group
Date of surgery	1992–1999	2000–2003
No. patients	121	115
Sex		
Male	103	95
Female	18	20
Mean age (years ± SD)	63.3 ± 8.8	63.7 ± 9.2
History of radiation or chemoradiation therapy		
Yes	30	29
No	91	86
Procedure for fitting jejunum to large pharyngeal defect	Oblique incision Antimesenteric incision	Longitudinal incision at any location
State of the jejunum	Not monitored	Tense and straight

TABLE 3. Patient Characteristics and Nasal Regurgitation

	Regurgitation	No Regurgitation	P (χ^2 test)
Sex			
Male	57	135	1.00
Female	11	26	
Age (years)			
>65	32	79	0.78
<65	36	82	
History of radiation or chemoradiation therapy			
Yes	13	40	0.45
No	55	121	
Type of defect			
Horizontal	52	138	0.09
Oblique	16	23	
Patient group			
Standardized method	41	70	0.02
Nonstandardized method	27	90	

frequent by 2 patients (5%). The time required to eat dinner after surgery as a percentage of the time required before surgery was 100% in 19 patients (47.5%), 150% in 12 patients (30%), 200% in 6 patients (15%), and 250% in 3 patients (7.5%).

Of the 40 patients who completed questionnaires, 12 (30.0%) used esophageal speech as the primary means of communication, 11 (27.5%) used an electrolarynx, and 17 (42.5%) used pen and paper. Of the 12 patients who used esophageal speech, 6 did not require any device, such as an electrolarynx or pen and paper, although 5 of 6 found it necessary to communicate with a person face-to-face. Overall, 23 patients (57.5%) communicated by means of audible sound, such as through esophageal speech or electrolarynx, and 10 patients (25%) could talk on the telephone. However, 14 patients (35%) communicated only with their family (Table 6).

After discharge, 17 of 40 patients took part in a speech rehabilitation program at the Society for Aphonia Patients. Twelve (70.6%) of these 17 patients successfully acquired esophageal

TABLE 4. Stricture of Distal Anastomosis

	Stricture	No Stricture	P (χ^2 test)
Radiation or chemoradiation therapy			
Yes	6	47	0.74
No	23	153	
Adjuvant radiotherapy			
Yes	4	18	0.41
No	25	182	
Type of anastomosis			
Mechanical	7	3	<0.01
Manual	22	197	
Patient group			
Standardized method	7	104	<0.01
Nonstandardized method	22	96	

TABLE 5. Characteristics of Forty Patients Completing the Questionnaire

	Nonstandardized Treatment Group	Standardized Treatment Group
No. patient	6	34
Sex		
Male	5	24
Female	1	10
Mean age (years ± SD)	68.2 ± 7.5	65.1 ± 8.4
Mean duration of follow-up when questionnaire completed (mo ± SD)	54 ± 11	23 ± 13

speech as the primary mode of communication. Of the other 5 patients, 2 were unwilling to undergo additional rehabilitation because they were satisfied with communicating with an electrolarynx or pen and paper, and 3 patients abandoned esophageal speech because they could not vibrate the air stream owing to poor abdominal muscle tone.

DISCUSSION

Owing to advances in microvascular surgery, FJT is widely used for reconstruction after pharyngolaryngectomy. FJT fails in 5% to 10% of cases,[3] most often because of problems related to microvascular anastomosis. The success rate at our institution is 97.9% and is, therefore, acceptable. In addition, our early postoperative death rate is 2.1%, which is similar to rates in recent studies.[4,5,13,14] Although FJT is generally reliable, some functional problems remain.

In the present series all surviving patients but 2 (who had hypoglossal nerve palsy) could resume postoperative oral intake an average of 13 days after surgery (range, 6–103 days). However, some patients complained of dysphagia caused by anastomotic stricture or of nasal regurgitation. Nasal regurgitation was observed in 30% of patients but gradually resolved in 60.3% of them. Regardless of the FJT procedure used, within 110 days from the start of oral intake, nasal regurgitation improved without treatment in all patients. Even though nasal regurgitation remained in 11.8% of our patients, these patients could tolerate oral intake and did not require tube feeding. Long-term follow-up results indicate that the time required for oral intake in most patients was not significantly longer after FJT than before surgery.

TABLE 6. Ability and Primary Mode of Communication

	Communication Ability*					
	I	II	III	IV	V	
Pen and paper	9	5	3 (1)	0	0	17 (1)
Electrolarynx and pen and paper	1	1	0	0	0	2
Electrolarynx	1	0	1	5 (3)	2 (1)	9 (4)
Esophageal speech and device	2	1	1	1	1	6
Esophageal speech	1	3	1	0	1 (1)	6 (1)
Total	14	10	6 (1)	6 (3)	4 (2)	40 (6)

*I: able to communicate with family.
II: able to communicate with family and acquaintances.
III: able to communicate with complete stranger (face to face).
IV: able to talk to family or acquaintance on the telephone.
V: able to talk to anyone on the telephone.
Number of patients treated with nonstandardized method is shown in parenthesis.

Although some studies have examined swallowing function or the development of stricture after FJT, we know of no study that has examined the incidence of nasal regurgitation after FJT.[4–7,14,15] How nasal regurgitation develops after FJT is unclear. One possible mechanism is extended resection of the oropharynx, which results in an oblique defect.[16] However, the regurgitation rate did not differ significantly between patients with horizontal defects and those with oblique defects. In contrast, the frequency of nasal regurgitation was significantly higher in the standardized procedure group than in the nonstandardized procedure group. Therefore, we speculate that nasal regurgitation is caused by impaired nasopharyngeal mobility, which is in turn caused by anastomosis of a tensed and straight jejunal graft. Spontaneous improvement of nasal regurgitation supports this possibility because tensile strength of the graft would gradually decrease after surgery. These results suggest that our standardized method increases the risk of nasal regurgitation after FJT, but we believe that postoperative swallowing function would not be significantly affected.

Stricture formation at the esophagojejunal anastomosis is another common complication after FTJ, occurring in 7% to 50% of cases.[4–9,14–18] The rate of stricture in our series was 12.7% overall and was significantly lower in patients with manual suture anastomosis and in patients of the standardized procedure group. Although stricture formation has several causes, the most common cause of stricture is tumor recurrence at the site of FJT.[6,15,19] In the present study, we excluded patients with recurrent disease and considered only the effects of the surgical procedure. Another cause of stricture is mechanical anastomosis. Previous studies have yielded contradictory results regarding whether manual suture increases the incidence of stricture.[15,19–21] In our series, the rate of stricture was extremely high (70%) with mechanical anastomosis. At present, we perform mechanical anastomosis only if the stump of the esophagus is deep and difficult to suture manually. Stricture may also be related to some voice-restoration procedures that are performed after FJT. In previous studies, tracheoesophageal or tracheojejunal puncture or elephant trunk shunt was performed to restore the voice, but these procedures increase the rate of stricture formation[3–9,14,18,22] and may induce aspiration pneumonia.[6,9,22] In our series, we did not perform these procedures and could avoid related complications, such as stricture formation and aspiration pneumonia. The most notable result is the lower incidence of stricture when the transferred jejunal graft was tensed and straight.

Another important functional consideration after FJT is how the patient can communicate without vocal cords. We used a questionnaire to analyze communication methods in 40 long-surviving patients. Twelve (70.6%) of 17 patients who participated in esophageal speech rehabilitation could use esophageal speech as their primary means of communication. Previous studies had suggested that esophageal speech is more difficult to acquire by patients treated with pharyngolaryngectomy and FJT than by patients treated with simple total laryngectomy.[16,23–25] Shibusawa[24] has reported that the pharyngoesophageal resting pressure is higher in patients with good esophageal speech than in patients with poor esophageal speech despite undergoing FJT, and is higher in patients treated with total laryngectomy than in patients treated with FJT; therefore, Shibusawa emphasizes the importance of an appropriate resting pressure for good phonation in patients treated with FJT. Previous studies have also shown that the phonation of esophageal speech is clearer after total laryngectomy or tracheoesophageal puncture than after tracheojejunal puncture.[22,26–28] Although a vibratory source is necessary to produce an audible and intelligible voice, the innervated thyropharyngeus muscle of the remnant pharyngeal wall plays an important role after tracheoesophageal puncture or total laryngectomy.[22] However, patients who have undergone FJT and tracheojejunal puncture do not possess the regulating mechanism provided by the thyropharyngeus muscle. In our study, esophageal speech was acquired by 12 patients, 11 of whom were of the standardized procedure group. Even though it would be subject to bias, because a subset of nonstandardized procedure group was not likely to have survived for follow-up in 2004 through 2005, the tension of the grafted jejunal segment may help maintain the resting pressure and compensate for the absence of the thyropharyngeus muscle. We believe that our tensed and straight jejunal method is useful for restoring phonation and for avoiding stricture. So, we demonstrate for all patients how to use the electrolarynx before discharge, and also encourage our patients to participate in esophageal speech rehabilitation as soon as possible after surgery.

In conclusion, we believe that our standardized method can reduce the incidence of stricture and encourages good swallowing function. Furthermore, this method can be used to restore esophageal speech without a tracheoesophageal or elephant trunk shunt. Although nasal regurgitation soon after oral intake is resumed is a disadvantage, we believe that it would not have a severe effect on patients' lives.

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Analysis of Salvage Treatments following the Failure of Free Flap Transfer Caused by Vascular Thrombosis in Reconstruction for Head and Neck Cancer

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Background: Few authors have reported the subsequent treatment for patients in whom free tissue transfers in the head and neck have failed as a result of vascular thrombosis.

Methods: Between 1993 and May of 2005, 502 free flaps were transferred after head and neck cancer ablation in the authors' hospital, 19 of which resulted in total necrosis caused by vascular thrombosis. The authors categorized these 19 cases into four groups and analyzed the salvage treatment.

Results: For failed free jejunal transfer, early initiation of oral intake was obtained when another free jejunum was transferred. For failed free soft-tissue transfer for intraoral defects, reconstruction with common free (first choice) or pedicled flaps was used: a voluminous musculocutaneous flap for extensive defects, forearm flap or pedicled pectoralis major flap for intermediate defects, and direct closure for small defects of the oral floor. For failed secondary soft-tissue transfer to improve a certain function, salvage flap transfer was not chosen in the acute setting. For failed secondary maxillary reconstruction, simple reconstruction using the rectus abdominis musculocutaneous flap combined with costal cartilage achieved stable results. The overall success rate of the repeated free flap was 89 percent (eight of nine patients).

Conclusions: When a free flap is judged unsalvageable, surgeons should determine subsequent treatments, considering the success rate as one of the most important factors. The authors believe that simple reconstruction using a common free flap is the first choice in most cases. When regional or general conditions do not permit further free flap transfer or when defects are comparatively small, reconstruction with a pedicled flap or direct closure of the defect may be considered. (*Plast. Reconstr. Surg.* 119: 1223, 2007.)

Over the past decade, free tissue transfer with microvascular anastomosis has progressed and is widely used for the reconstruction of defects following cancer ablation in the head and neck. The reported overall success rates remain at 95 to 97 percent,[1–4] although microvascular skills and instruments have improved. Failure caused by vascular thrombosis is inevitable and frequently leads to devastating results. When vascular thrombosis is detected, prompt surgical reexploration is undertaken to salvage the free flap. However, successful salvage rates have been reported to range from 28 to 87.5 percent,[1,3,5,6] and subsequent salvage reconstruction is required for unsalvaged cases. Salvage reconstruction is generally challenging and difficult because the most suitable flap has already been used in the first reconstruction and the available recipient vessels for microvascular free tissue transfer are limited. The risk of infection and delayed wound healing is high because of inflammation caused by leakage of saliva or digestive juices. Furthermore, repeated operations result in a poor general condition, which does not permit further surgery that involves

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considerable invasion or lengthy operating time. There have been many reports on the complications of free tissue transfers in the head and neck,[1–3,5–8] but few have analyzed the subsequent treatment for cases that have failed because of vascular thrombosis. In this article, we analyze our cases with total flap necrosis caused by vascular thrombosis in the head and neck and discuss the optimal treatment according to the defect type.

PATIENTS AND METHODS

A retrospective chart review of 502 patients who had undergone free flap transfer after cancer ablation in the head and neck between 1993 and May of 2005 at the University of Tokyo Hospital identified 19 patients (3.8 percent) with total necrosis of the transferred flap caused by arterial [13 of 19 (68 percent)] or venous [six of 19 (32 percent)] thrombosis. In our series, both immediate and secondary reconstructions were included. There were four women and 15 men ranging in age from 30 to 80 years, with an average of 58 years. Reconstruction was immediate in 10 and secondary in nine. The average follow-up was 20 months (range, 3 to 66 months). These 19 patients were divided into the following four groups for the sake of convenient analysis:

Group I (n = 4): Patients who underwent free jejunal transfer following pharyngoesophagectomy for hypopharyngeal cancer.
Group II (n = 7): Patients who underwent immediate reconstruction using a free flap other than the intestines.
Group III (n = 2): Patients who underwent secondary soft-tissue reconstruction with a free flap to improve a certain function.
Group IV (n = 6): Patients who underwent secondary bony reconstructions with free vascularized bone or osteocutaneous flap transfer.

The age of the patients, disease, methods of cancer resection, flap used in the initial reconstruction, and thrombosed vessels (artery or vein) are listed in Table 1.

The validity of the treatments at flap loss was assessed based on the following parameters:

Group I: Time required by the initiation of oral intake, and quality of diet.
Group II: Time required by the initiation of oral intake, quality of diet (swallow function), and speech.
Group III: Functional improvement.
Group IV: Success rate of flap survival, control of

Table 1. General Summary of the Four Groups

Group	Sex	No.	Average Age (yr)	Disease	No.	Method of Cancer Ablation	No.	Flap Used	No.	Thrombosed Vessel	No.
I	F	1	62–80	Hypopharyngeal cancer	4	Pharyngolaryngoesophagectomy	4	Jejunum	4	Artery	2 (3)*
	M	3	(71)							Vein	2
II	F	1	48–74	Lingual cancer	4	Total glossolaryngectomy	1	RAMC	3	Artery	6
	M	6	(60)	Buccal mucosal cancer	1	Subtotal glossectomy	2	ALT	2	Vein	1
				Oral floor cancer	2	Hemiglossectomy	1	Forearm	1		
						Marginal mandibulectomy	1	Upper arm	1		
						Local resection	2				
III	F	1	30, 56	Intraoral contracture	1			Forearm	1	Artery	1
	M	1		Facial palsy, fistula	1			LDMC	1	Vein	1
IV	F	2	42–58	Maxillary defect	4			Forearm plus scapular osteocutaneous	2	Artery	4
	M	4	(52)	Mandibular defect	2			Forearm with radius	1	Vein	2
								Scapular osteocutaneous	1		
								Iliac bone	1		
								Fibular osteocutaneous	1		
I–IV	F	4	30–80							Artery	13 (14)*
	M	15	(58)							Vein	6

RAMC, rectus abdominis musculocutaneous; ALT, anterolateral thigh; LDMC, latissimus dorsi musculocutaneous; M, male; F, female.
*Both the artery and vein were thrombosed in patient 2.

infection, aesthetic appearance, and smoothness of oral intake.

Statistical analysis was not performed because the sample sizes were small within the groups.

RESULTS

Patient summaries are listed in Tables 2 through 5.

Group I

In group I (Table 2), in two of four patients, another jejunal segment was harvested and transferred, and continuity of the esophagus was obtained successfully without leakage. Of these two patients, one commenced oral intake 10 days postoperatively and could eat normally, whereas in the other patient, the retransferred jejunum survived well without leakage but oral intake was started on postoperative day 50 because of serious cerebral infarction after the salvage operation. The patient had a soft diet.

In contrast, the other two patients underwent pharyngostoma and esophagostoma formation and coverage of the posterior wall of the pharyngoesophagus with a deltopectoral flap. Further reconstruction of the cervical esophagus was carried out with a pectoralis major musculocutaneous flap 63 days postoperatively in one patient and with pectoralis major musculocutaneous and deltopectoral flaps 154 days postoperatively in the other patient. Minor leakage occurred in these cases, and the initiation of oral intake occurred on postoperative days 108 and 197, respectively. These two patients could eat only gruel.

Group II

In group II (Table 3), in five patients whose defects were over half of the tongue or involved a mandibular bone, a free flap or pedicled musculocutaneous flap was used in the salvage reconstruction. Of these, one patient underwent a total glossectomy with laryngectomy for recurrent lingual cancer and immediate reconstruction with a rectus abdominis musculocutaneous free flap. Arterial thrombosis developed 3 hours postoperatively. Although thrombectomy and arterial anastomosis were achieved twice thereafter, the flap became unsalvageable. As thick scarring involved recipient vessels, we gave up on retransferring the free flap and chose reconstruction with a pedicled latissimus dorsi musculocutaneous flap. Leakage occurred postoperatively and took approximately 5 weeks to close with conservative treatment. The

Table 2. Patient Summary for Group I

Case	Age (yr)	Sex	History	Artery	Vein	Onset (POD)	Treatment at Thrombosis	Course	Initiation of Diet (POD)	Result	Follow-Up (POM)
1	62	M	NP	TCA	IJV†	3	Free jejunum (TCA, IJV)	No complication	11	Early initiation of oral intake, normal diet	15, death
2	68	M	Diabetes mellitus, arteriosclerosis obliterans, Y-graft for abdominal aortic aneurysm	STA*†	IJV†	3	Free jejunum (TCA, EJV)	No leakage, cerebral infarction (POD 6)	50	Soft diet	7, death
3	80	M	Diabetes mellitus, arteriosclerosis obliterans, myocardial infarction	STA†	IJV	8	DP, pharyngostomy, esophagostomy	PMMC, DP (POD 154), minor leakage	197	Gruel	8
4	74	F	Hypertension, cerebral infarction	STA†	IJV	2	DP, pharyngostomy, esophagostomy	PMMC (POD 63), minor leakage	108	Gruel	16

TCA, transverse cervical artery; STA, superior thyroid artery; IJV, internal jugular vein; EJV, external jugular vein; PMMC, pectoralis major musculocutaneous; DP, deltopectoral; POD, postoperative day; POM, postoperative month; NP, nothing particular; M, male; F, female.
*Both the artery and vein were thrombosed.
†Thrombosed vessel.

Table 3. Patient Summary for Group II

Case	Age (yr)	Sex	Disease (Preoperative RT)	Operation	Flap	Artery	Vein	Onset (POD)	Treatment at Thrombosis	Course	Initiation of Diet (POD)	Result	Follow-Up (POM)
5	74	M	Lingual cancer, PMMC reconstruction, recurrence (70 Gy)	Total glossolaryngectomy	RAMC	TCA*	IJV	0	Pedicled LDMC	Minor leakage, healed conservatively (RT = 50 Gy)	45	Gruel, died as a result of cancer recurrence	11, death
6	52	F	Lingual cancer recurrence (30 Gy)	Subtotal glossectomy	RAMC	TCA*	IJV	1	RAMC	Subcutaneous infection, healed conservatively (RT = 50 Gy)	54	Misswallowing, gruel, died as a result of cancer recurrence	5, death
7	72	M	Lingual cancer	Subtotal glossectomy	RAMC	FA*	IJV	1	RAMC (necrosis again, arterial thrombosis)	PMMC and DP (POD 7), minor leakage	40	Almost normal diet	6
8	48	M	Lingual cancer	Hemiglossectomy	ALT	FA*	IJV	1	Forearm	No complication	15	Normal diet, acceptable speech	66
9	60	M	Buccal mucosal cancer	Marginal mandibulectomy	Forearm	STA	IJV*	4	ATL	No complication	35	Normal diet, acceptable speech	30
10	51	M	Oral floor cancer	Local resection (4 × 8 cm)	Upper arm	STA*	IJV	1	Debridement only	No complication	14	Normal diet, acceptable speech	36
11	65	M	Oral floor cancer	Local resection (4 × 8 cm)	ALT	STA*	IJV	2	Debridement only	No complication	20	Normal diet, slight speech intelligibility	27

TCA, transverse cervical artery; STA, superior thyroid artery; FA, facial artery; LA, lingual artery; IJV, internal jugular vein; PMMC, pectoralis major musculocutaneous; RAMC, rectus abdominis musculocutaneous; ALT, anterolateral thigh; LDMC, latissimus dorsi musculocutaneous; DP, deltopectoral; POD, postoperative day; POM, postoperative month; RT, radiation therapy; M, male; F, female.
*Thrombosed vessel.

Table 4. Patient Summary of Group III

Case	Age (yr)	Sex	History	Disease	Flap	Artery	Vein	Onset (POD)	Treatment at Thrombosis	Course	Result	Follow-Up (POM)
12	56	M	Atrial fibrillation	Intraoral contracture, post-gingival cancer	Forearm	TCA*	EJV	0	Skin graft	Partial skin graft	Contracture, somehow released, recontracture	15
13	30	M	NP	Facial palsy and fistula, post-osteosarcoma of the mandible	LDMC	STA	FV*	6	Debridement only	Local flap, skin graft	Fistula closed, facial palsy no change	8

TCA, transverse cervical artery; STA, superior thyroid artery; EJV, external jugular vein; FV, facial vein; LDMC, latissimus dorsi musculocutaneous; POD, postoperative day; POM, postoperative month; NP, nothing particular; M, male; F, female.
*Thrombosed vessel.

patient began to eat perorally on postoperative day 45 day and had gruel.

In two patients who underwent subtotal glossectomy for lingual cancer and reconstruction with a rectus abdominis musculocutaneous flap, the contralateral rectus abdominis musculocutaneous flap was used for salvage reconstruction. In one patient, the reconstruction itself was successfully achieved with voluminous oral floor and root of the tongue, but the initiation of the peroral diet was postoperative day 54 because ingestion was difficult as a result of misswallowing. In the other patient, the flap degraded into total necrosis again because of arterial thrombosis. Reconstruction with a pedicled pectoralis major musculocutaneous and deltopectoral flap was performed. A peroral diet was initiated on postoperative day 40 and the patient could eat normal food.

One patient who underwent reconstruction with an anterolateral thigh flap following hemiglossectomy received a radial forearm flap transfer at salvage reconstruction. One patient who underwent reconstruction with a radial forearm flap following marginal mandibulectomy had anterolateral thigh flap transfer at salvage. In these two patients, no leakage occurred postoperatively, and both had acceptable speech and ate a normal diet.

In two patients with comparatively small defects (4 × 8 cm) of the oral floor, only debridement of the necrotic flap (anterolateral thigh, upper arm flap) and direct closure were selected. No leakage occurred postoperatively. These two patients could eat normally, although the restricted mobility of the tongue caused some speech ambiguity in one patient.

Group III

In group III (Table 4), one patient underwent free forearm flap transfer following release of the intraoral contracture. Arterial thrombosis occurred 8 hours postoperatively. Revascularization was achieved after reexploration. Thrombosis redeveloped after several hours and revascularization could not be achieved. We considered that the repeated arterial thrombosis might be associated with refractory atrial fibrillation with arrhythmia. We gave up on another free flap transfer and peeled the skin from the unsalvaged flap to use as a skin graft. The intraoral contracture was released incompletely.

One patient underwent functional reconstruction for facial palsy and orocutaneous fistula with a free latissimus dorsi musculocutaneous flap. On the first postoperative day, venous and arterial thrombosis developed. Revascularization using in-

Table 5. Patient Summary of Group IV

Case	Age (yr)	Sex	Disease (preoperative RT)	Flap	Artery	Vein	Onset (POD)	Treatment at Thrombosis	Course	Result	Follow-Up (POM)
14	42	M	Maxillary cancer maxillectomy, RAMC flap (FA, FV), parascapular OsC flap (LA, FV) (70 Gy)	Forearm with radius	STA (artery graft)	CFV* (venous graft)	5	Debridement of soft tissue, preserving bone	Removal of sequestrum, extracorporal RAMC flap with costal cartilage graft (POD 350)	No fistula formation, acceptable appearance, smooth oral intake	38
15	58	F	Maxillary cancer maxillectomy (70 Gy)	Scapular osteoadiposal	FA*	FV (venous graft)	Untraced	Debridement of soft tissue, preserving bone	Removal of sequestrum, RAMC flap with costal cartilage graft (POD 62)	No fistula formation, acceptable appearance, smooth oral intake	28
16	51	M	Maxillary cancer maxillectomy (40 Gy)	Forearm and scapular osteocutaneous	STA*	CFV	5	Debridement of soft tissue and bone	Observation	No change	3
17	50	M	Maxillary cancer maxillectomy (64 Gy)	Forearm and scapular osteocutaneous	STA*	EJV	4	Debridement of scapular flap, preserving FA flap and bone	Removal of sequestrum (POD 321)	No change	15
18	56	M	Mandibular defect, plate exposure (70 Gy)	Iliac bone	STA*	IJV	5	Debridement of soft tissue, preserving bone	Removal of sequestrum, fibular osteocutaneous with forearm flap (POD 150), venous thrombosis (POD 158), salvaged	No fistula formation, acceptable appearance, smooth oral intake, denture installed	25
19	57	F	Radionecrosis of the mandible (70 Gy)	Fibular osteocutaneous	TCA	IJV*	1	Debridement of soft tissue, preserving bone, DP flap	Removal of sequestrum (POD 76)	No change	20

TCA, transverse cervical artery; STA, superior thyroid artery; FA, facial artery; LA, lingual artery; IJV, internal jugular vein; EJV, external jugular vein; FV, facial vein; CFV, common facial vein; RAMC, rectus abdominis musculocutaneous; POD, postoperative day; POM, postoperative month; RT, radiation therapy; OsC, osteocutaneous; M, male; F, female.
*Thrombosed vessel.

terposed arterial and venous grafts was achieved. The next day, arterial thrombosis occurred but revascularization was achieved again. On postoperative day 6, however, venous thrombosis occurred. Revascularization could not be achieved despite an emergent operation. Debridement of the necrotic tissue was selected because the patient did not want further surgery at that time. Local flap transfer with a skin graft closed an orocutaneous fistula, but facial palsy remained unchanged.

Group IV

In group IV (Table 5), all six patients had a history of preoperative irradiation (40 to 70 Gy) and underwent reconstruction with free vascularized bone or osteocutaneous flaps. When the transferred free flaps were judged unsalvageable, five patients were treated conservatively with only debridement, whereas one patient (patient 19) underwent bone coverage with a deltopectoral flap in addition to removal of necrotic soft tissue. All transferred tissue was removed in one (patient 16) of six patients, whereas only soft tissue was removed while preserving bone in five patients. In all of the latter five patients, however, the bone degraded into sequestrum and was subsequently removed. Further reconstructions were performed in three patients but not in another three patients because they did not want further surgery. Salvage reconstructions performed in the former three patients were as follows. One patient underwent transfer of an extracorporeal rectus abdominis musculocutaneous flap with costal cartilage graft after a year. Further surgery with a tensor fascia lata graft was also performed. One patient underwent the transfer of a rectus abdominis musculocutaneous flap with costal cartilage approximately 2 months postoperatively that survived completely. These two patients obtained acceptable appearance and regular oral intake without fistula formation. One patient (patient 18) underwent reconstruction with conjoined fibular osteocutaneous and forearm flaps on postoperative day 150. The flaps developed venous thrombosis 7 days postoperatively but were salvaged with thrombectomy and venous reanastomosis, and survived completely. In this patient, dentures were installed successfully afterward and an acceptable appearance with regular oral intake was achieved.

DISCUSSION

Group I

In patients with advanced hypopharyngeal cancer who have undergone a pharyngoesophagectomy, the 2- and 5-year disease-specific survival rates are not high (72 and 52 percent, respectively).[9] Postoperative irradiation therapy is occasionally added.[10,11] Thus, in this group, early wound healing and early initiation of oral intake are in the patient's best interest. Free jejunal transfer is the most standard and reliable procedure of pharyngoesophageal reconstruction because of low complication rates and lower donor-site morbidity.[8,12] In free jejunal transfers, however, once vascular thrombosis occurs postoperatively, salvage with thrombectomy and reanastomosis is difficult because more than 3 hours' ischemia causes irreversible damage to the jejunum.[13,14] Because the jejunal graft with thrombosis quickly degrades into necrosis and infection spreads in the hypopharyngeal space, a salvage operation with removal of the necrotic graft should be performed as soon as possible. We believe that the best management for failed free jejunal transfer is another free jejunal transfer, as the harvest of a new jejunal segment is easy. Reconstruction using the intestines has significant advantages over cutaneous or musculocutaneous flaps,[15] and this is also true in salvage reconstruction after initial graft loss.[16] When a general or regional condition does not permit celiotomy, the radial forearm flap is a conceivable option because it is less invasive and allows early mobilization.[8,17] Salvage reconstruction using a pedicled flap (e.g., pectoralis major musculocutaneous flap) should be used only in cases where recipient vessels are unavailable. In our two cases where free jejunal transfer was performed secondarily, we experienced little difficulty in harvesting the jejunum again. Boyd et al.[18] reported after an anatomical study of three fresh cadavers that any part of the jejunum or ileum is suitable for transfer in terms of the ratio of chord to arc length. Conservative treatment with pharyngostoma and esophagostoma formation requires several further operations and a long time to the initiation of oral intake. Patients 3 and 4 are our early cases.

Group II

In this group, early initiation of oral intake, final swallow function, and speech were measured to assess the subsequent treatments. When a free flap transferred at the initial intraoral reconstruction fails, the optimal treatment should be determined depending on the size and location of the defects. When a defect is not less than half of the tongue, salvage reconstruction with either a cutaneous or musculocutaneous flap (pedicled or

free) should be performed as permitted by the patient's general condition. If conservative treatment with the debridement of necrotic tissue and formation of pharyngostomy are carried out, several further operations are required before the initiation of oral intake. Such conservative treatments often make the general condition worse because of lasting inflammation in the pharyngeal space, and exposure of the large vessels might result in their rupture.

When the defects are extensive (e.g., subtotal or total glossectomy, total glossectomy with laryngectomy), we believe that salvage reconstruction with a voluminous free musculocutaneous flap is the first choice, such as a (contralateral) rectus abdominis musculocutaneous flap. In our two cases that received a salvage free rectus abdominis musculocutaneous flap transfer because of a failed free rectus abdominis musculocutaneous flap transfer, we experienced little difficulty in reharvesting the rectus abdominis musculocutaneous flap. A weakened abdominal wall is a probable complication, for which reinforcement of the abdominal wall with a tensor fascia lata flap or artificial mesh is mandatory to prevent hernia. A free latissimus dorsi musculocutaneous flap is a possible alternative for such a large defect. In one series, one patient underwent pedicled latissimus dorsi musculocutaneous flap transfer as salvage reconstruction because the scar spread over the operating field and no appropriate recipient artery was available near the defect. End-to-side anastomosis to the external carotid artery or the use of the thoracoacromial artery as a recipient was a probable option, but we considered that the patient's general condition would not permit further surgery if thrombosis reoccurred.

When the defects are intermediate (e.g., hemiglossectomy), the use of a radial forearm flap is preferred to an anterolateral thigh perforator flap because the radial forearm flap is technically easier to transfer and has lower failure rates than the anterolateral thigh flap.[19] Surgeons should consider the flap success rate as the most important factor in choosing the flap, especially after loss of the initial flap. In one patient, however, an anterolateral thigh flap was used in the salvage reconstruction because the left forearm flap had already been used and nutrient vessels of the right forearm were damaged by arterial and venous lines. Our two patients in this category experienced no complications after salvage operation and could eat normally and had acceptable speech. A pectoralis major musculocutaneous flap is a conceivable alternative for such defects. When the defects are restricted for the most part to the oral floor, direct closure of the defect is possible,[20] although salvage reconstruction with a free flap or pedicled flap is better from a functional viewpoint.[21] In two patients with a defect of the oral floor, direct closure of the defect was chosen at the time of flap loss. These two patients commenced oral intake by postoperative week 3 and ultimately ate normal food, although the speech of one patient could not be well understood.

Group III

Reconstructions performed in group III were secondary and were designed chiefly for the purpose of functional improvement. In such cases, flap loss means little change in the recipient between the preoperative and postoperative states, whereas another free flap transfer requires another donor-site sacrifice. Thus, in this group, consideration of the patient's opinion and the estimated rate of success determine whether salvage reconstruction should be performed in the acute setting soon after thrombosis. When the release of contracture is the chief objective of surgery, a skin graft using a portion of skin taken from the lost flap can provide some improvement. Because our patient 11 had refractory arterial fibrillation, which we consider a serious cause of arterial thrombosis, we rejected the retransfer of the free flap. When a free flap transfer failed because of arterial thrombosis in patients with refractory atrial fibrillation, the indication of another free flap transfer should be determined after due consideration because the previous arterial thrombosis might be associated with atrial fibrillation.

Group IV

Group IV comprised the most challenging cases because the reconstructions were secondary, preoperative irradiation had been performed, and bony reconstruction was required in all cases. In this group, the success rate of flap survival, control of infection, and the aesthetic appearance and smoothness of oral intake should be included to evaluate the salvage treatment. Nakatsuka et al.[3] reported that the flap survival rate in secondary reconstruction was significantly lower than in immediate reconstruction because the available recipient vessels are limited and the risk of infection and delayed wound healing is predominantly attributable to scar formation and persistent inflammation caused by digestive juices. Furthermore, osteocutaneous flaps were almost five times more likely to fail than soft-tissue flaps.[2] In our series,

when the transferred osteocutaneous or osteoadiposal flap was judged unsalvageable, only the soft tissue was removed, preserving bone in five of six cases. However, postoperative follow-up revealed that the grafted bone degraded into the sequestrum and was subsequently debrided in all five cases. In regions other than the head and neck, a free (nonvascularized) bone graft is one option for bony reconstruction. However, in the nasopharyngeal space, nonvascularized bone can sustain infection and degrade into the sequestrum, especially in secondary cases. Successful reconstruction of maxillary defects with a free vascularized bone (osteocutaneous) flap has been reported, including fibular,[22] scapular,[23] radial,[24] and iliac[25] bone or osteocutaneous flap. In general, however, osteocutaneous flaps (fibular, scapular, iliac) do not have a vascular stalk as long as that of the rectus abdominis musculocutaneous or the latissimus dorsi musculocutaneous flap. In our initial free flap transfer for maxillary reconstruction, venous and/or arterial interposition was used in two cases to obtain a long vascular pedicle, and a scapular osteocutaneous flap was used with a forearm flap in two cases. Flaps requiring a vein graft have a higher rate of flap loss than those that do not.[2] It may not be in the patient's best interest for a bone flap transfer such as a fibular flap to be repeated in the acute setting at the time of flap loss. When a secondary bony reconstruction fails because of vascular thrombosis, we consider that free rectus abdominis musculocutaneous or latissimus dorsi musculocutaneous flap transfer combined with costal cartilage or rib[26,27] is the recommended option because latissimus dorsi musculocutaneous and rectus abdominis musculocutaneous flaps have long pedicles with large-caliber vessels that are technically easier to work with. These flaps can also be used in an extracorporeal manner. Extracorporeal transfer requires only minimal dissection in the recipient, which can avoid exposure of the great vessels and spread of infection. The use of a titanium mesh in combination with a rectus abdominis musculocutaneous flap[28] or simple maxillary reconstruction using a rectus abdominis musculocutaneous flap and prostheses[29] is an option to be considered. Salvage reconstruction using a common osteocutaneous flap with another flap or with a vein and/or arterial graft would result in a high rate of vascular thrombosis.

Once the free flap used in the immediate reconstruction is judged unsalvageable, salvage reconstruction should be performed as promptly as possible. Treatment delay causes the spread of infection and may result in exposure of the great vessels, leading to rupture. Salvage treatment should be determined following the patients' wishes, considering many factors including regional and general conditions and existing complications, of which the success rate should be considered by surgeons as the most important factor. Even in salvage reconstruction after free flap loss, we believe that retransfer of the free flap is the best choice for large soft-tissue defects to the extent that general and regional conditions permit. In our series, the success rate of the repeated free flap was 89 percent (eight of nine patients): five of six patients (83 percent) who underwent soft-tissue reconstruction in the acute setting and three of three patients (100 percent) who underwent soft- and hard-tissue reconstruction in the late setting. Compared with the pedicled flap, free flap transfers have the advantage of a large degree of freedom for transfer and good blood supply throughout the flap. In free flap transfer in the head and neck, partial necrosis of the flap is rare,[2,3] whereas the pedicle flap tends to sustain partial necrosis of the distal parts, especially in cases where a large flap is required. When regional and general conditions do not permit further free flap transfer or when defects are comparatively small, re-reconstruction with a pedicled flap should be considered. We occasionally have difficulty in selecting suitable recipient vessels for the retransfer of free flaps. When branches of the external carotid or subclavian artery are not available for the recipient, we prefer to apply end-to-side anastomosis directly to the external carotid artery.[30] The thoracoacromial artery is also usable. Regarding the recipient vein, at least one of the internal or external jugular veins is usable in most cases. When none is available, a turned-over cephalic vein or thoracoacromial system might be usable.[14]

CONCLUSIONS

When a free flap is judged unsalvageable, treatment should be determined on the basis of many factors, of which the success rate should be considered by surgeons as one of the most important. We believe that retransfer of the common free flap is the best choice for large soft-tissue defects at thrombosis. When the regional or general conditions do not permit further free flap transfer or when defects are comparatively small, re-reconstruction with a pedicled flap should be considered. For soft- and hard-tissue defects, simple reconstruction with a common free flap with a long vascular stalk such as the rectus abdominis musculocutaneous or latissimus dorsi musculocu-

taneous flap combined with costal cartilage or rib is the recommended option.

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遊離空腸移植術

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Key words：遊離空腸　マイクロサージャリー　下咽頭・頸部食道再建

はじめに

頭頸部癌切除後の再建において，血管柄付き遊離組織移植術（いわゆるfree flap）が果たしてきた役割はすでに論じるまでもなく，現在では多くの施設で再建方法の第1選択として用いられている[1)~3)]。

一方，頭頸部の再建手術が，ほかの外科手術と明らかに異なる点は，頭頸部癌の外科的切除後の欠損形態が症例ごとに大きく変わることである。したがって，その欠損に応じた臨機応変な対応が必要とされ，術者の経験や好みによって再建材の選択がなされることが多い。

これに対し，下咽頭癌などに対する咽喉食摘後の再建は，欠損形態もだいたい一定しており，移植組織も第1選択が遊離空腸になるという点では衆目の一致をみており，頭頸部再建の中でもスタンダードな手術といえる[4)~6)]。さらに，下咽頭部分切除の喉頭温存例や，下咽頭進展癌に対する広範囲切除例でも本法は有効であり，また音声管作製による音声再建方法[7)]も開発され，この領域で果たす役割は非常に重要である。

本稿では，主に定型的咽喉食摘後の遊離空腸移植術の基本的術式と合併症回避のための注意点につき述べる。

I 適　応

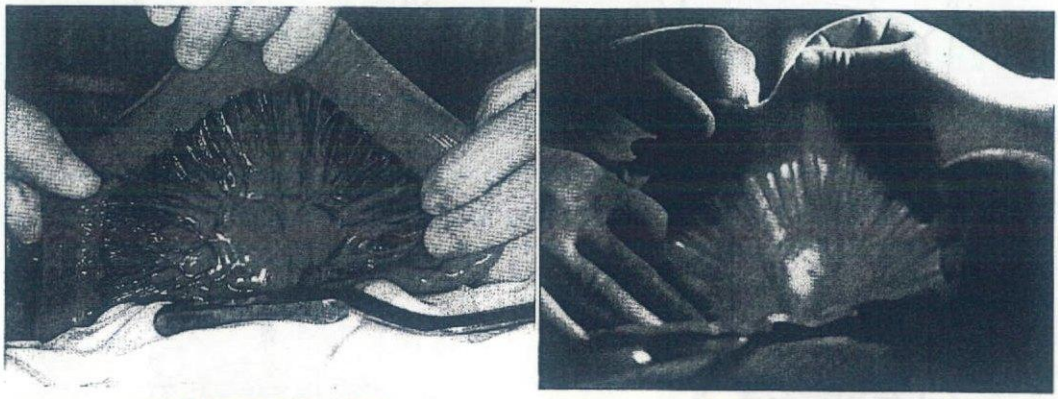
遊離空腸移植術が適応となるのは，本稿で述べたような下咽頭癌に対する咽喉食摘後や，胃管や結腸挙上による食道再建後の腸管部分壊死症例など，咽頭・食道の全周性欠損が代表例である。さらには喉頭温存を要するような限局性の下咽頭癌では，パッチ状に開いた空腸片の移植も適応となる[8)]。

逆に上記のような症例でも適応とならないのは，複数回の開腹手術の既往があり，腸管の高度な癒着が危惧される場合が考えられるが，そのような症例は一般に極めてまれといえる。また，頸部に適当な移植床血管がない場合も，本手術の適応ではないが，このような症例も極めてまれである。

II 手術手技の基本

1. 術前の準備

空腸採取の術前準備としては，通常の上部消化管の術前処置に準じ，手術前夜の夕食以降は禁食としておく。



(a) 脂肪の少ない症例
容易に血管を目視できる。

(b) 脂肪が厚い症例
透過光の下で観察する。

図1　腸間膜内の血管走行状態

2. 手術手技

1) 空腸の採取

空腸の採取にあたっては，通常まず消化器外科医により上腹部正中切開で開腹が行われ，Treitz 靭帯が確認される。ついで，空腸を持ち上げ腸間膜内の空腸動静脈の走行を確認する。

この際，腸間膜内の脂肪の量が少ない症例では，動静脈の走行は容易に確認できる。しかし，脂肪の量が多い症例では，肉眼での確認は難しく，腸間膜を広げ透過光の下で見るようにすると容易に観察することができる(図1)。

上腸間膜動静脈より派生する空腸動静脈のうち，口径が太く，長い血管柄として採取できる部位を栄養血管として選択するが，一般には第2ないし第3空腸動静脈がこの条件に適合する。栄養動静脈を決定すると，咽頭食道の欠損に合わせて採取すべき腸管の位置と長さを決める。

空腸は腸間膜に弧状に付着しており，腸管を直線状に長く移植すると栄養血管の可動性にはある程度の制限が生じる。その点を考慮して，腸管の弛みが少なく，かつ血管吻合部に過剰な緊張がかからないように採取しておく。つまり，移植床血管が頸部上方にある場合には栄養血管を中心として口側に短く肛門側に長く採取し，頸部下方の場合は口側に長く肛門側に短くなるようにする（図2)。

しかし，あらかじめ空腸を実際の欠損長よりかなり長めに採取しておけば，欠損部に移植した時に，後述するようにトリミングで調整することも十分可能である。

採取する空腸の部位が決定したら，栄養血管の剝離を行う。動静脈の走行位置を確認後，腸間膜を電気メスなどで浅く切り開き，細かい枝は丁寧に順次結紮しながら，基部で動静脈を露出させる。剝離する血管の長さはできるだけ長い方がよいことはいうまでもないが，特に頸部の移植床動静脈が近接していない時には，腹腔内操作のこの段階で動静脈間を十分に分離しておくことが必要である。

ついで，腸鉗子をかけ空腸を切離するが，移植する空腸の阻血時間をできるだけ少なくするために，頸部操作が終了しただちに空腸を移植できる状態になるまで血管柄は切断しないようにする。また，空腸を逆蠕動方向に移植しないように，空腸片の口側か肛門側かがわかるように糸などで目印をつけておく。

2) 頸部移植床の準備

頸部では，吻合に適した1対の移植床動静

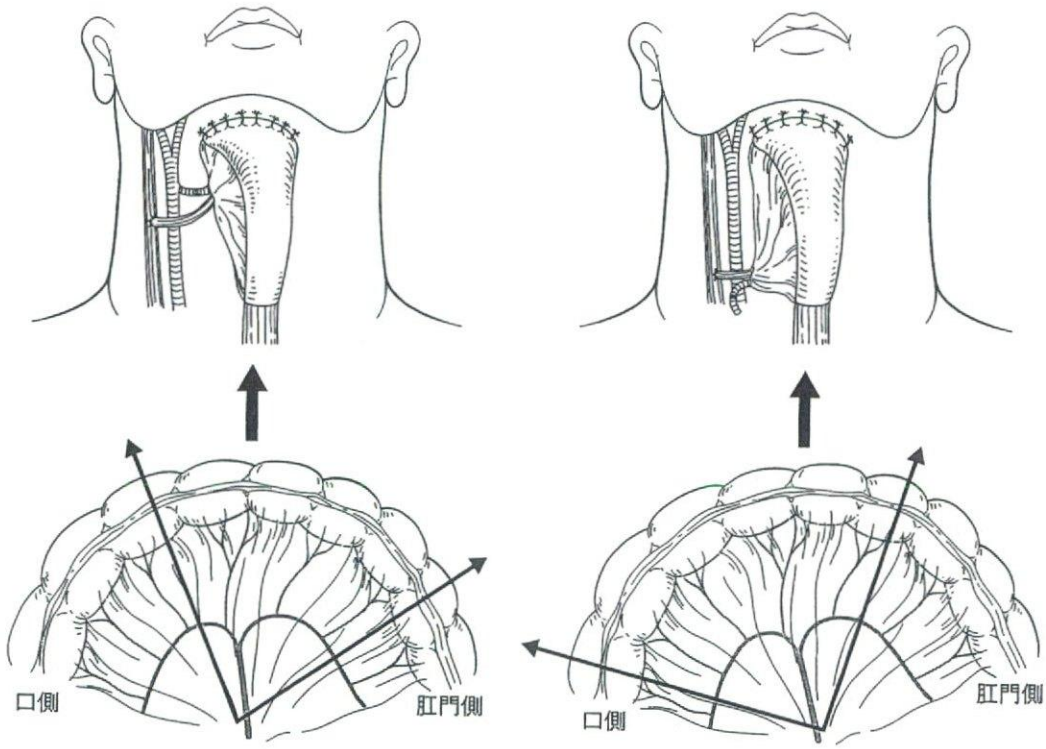


図2 空腸の採取部位の決定
頸部の吻合血管の位置に合わせ，採取する空腸片の部位を決める。

脈の存在を確認しておく。静脈では，内頸静脈への端側吻合を頻用しているので，頸部郭清後の捻じれや枝の結紮による狭窄がないかを確かめておく。動脈に関しては，ほとんどの場合上甲状腺動脈か頸横動脈が候補となり，口径や拍動のよいものを選んでおく。

なお，これらの血管が攣縮や乾燥をしないよう，生理食塩水や塩酸パパベリン（5～10倍希釈）を含んだガーゼを当てておく。

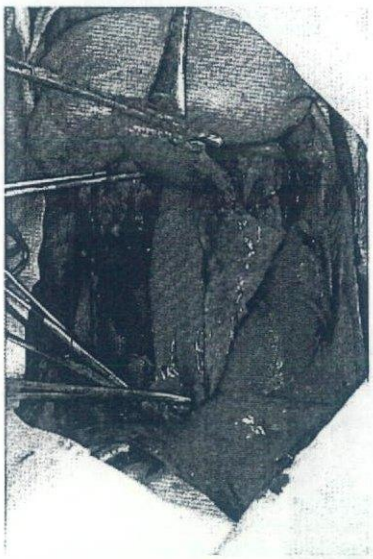
3）空腸片の頸部への移植・固定

採取した空腸を頸部に移植する際，われわれは通常まず腸管吻合から始め，粘膜縫合がほぼ終了した時点で血管吻合を行っている。血管吻合から始める方法もあるが，血管吻合を先に行うと，粘膜断端面からの出血や粘液の産出が腸管吻合の妨げとなる。さらに虚血時の方が粘膜面，漿膜面の見極めが容易で確実な粘膜縫合が可能となると考えている。腸管吻合を先に行っても，空腸自体の阻血時間が2時間半を越えることはないので，阻血再灌流障害などの問題を生じたことはない。

腸管吻合の実際であるが，まず血管吻合部に過剰な緊張がかからないように空腸のトリミングの位置を決める。この際，空腸はできるだけ伸展させた状態で上下端の吻合位置を決めている（図3-a）。

われわれは，最初に頸部食道側の吻合から開始している。その理由は，縫合不全による瘻孔が重篤な縦隔炎につながりかねない食道側の吻合を，十分な視野の下で最初に確実に行いたいからである。

腸管吻合に先立ち，空腸の切断面からはみ出した余剰の粘膜を切除し，粘膜下層断端を適宜電気凝固しておく。ついで，微小血管吻合と同様，まず頸部食道断端の左右端180°の位置を縫合し，それを支持糸として横方向



(a) 血管吻合部位を合わせながら，移植空腸をできるだけ伸展させた状態で，上下の切断位置を決定する。

図3　空腸片の移植固定方法

に十分広げた状態で，後壁を順次縫合する。後壁は全層一層縫合を基本とし，随時垂直マットレス縫合を加える（図3-b，c)。後壁の縫合終了後，移植空腸を下方に翻転し，裏面から縫合部の状態を確認し必要があれば漿膜縫合を追加する（図3-d)。

前壁の縫合は，Gambee縫合で行っている。なお，いうまでもないが，腸管吻合の基本は，粘膜が漿膜側にはみ出さないようつまり内腔面がinvertするように縫合することである。

ついで，咽頭側断端の縫合に移るが，前述のようにできるだけ空腸に緊張をかけた状態で移植されるようトリミングを行う。移植空腸が弛んでいると決して良好な嚥下機能が得られず，できるだけ直線状の再建食道を作製することが必要と考え，著者は1980年代後半からかなり緊張をかけた状態で移植している[9]。阻血時には咽頭食道欠損長の半分以下の空腸移植となるが，血流再開後は長さの余裕が生じ，術後はさらに頸部の伸展位が解除されるので結果として弛みのない再建食道が形成される（図3-e～h)。

なお，咽頭側断端の口径は空腸の口径よりかなり大きいため，空腸を斜めに切開することにより口径差を調整するようにする（図3-i)。

咽頭側も食道側と同様に，後壁は全層一層を基本とし，裏面からも縫合を確認後，前壁の縫合を行う（図3-j)。前壁の最後の3～4針はかけずにおき，この状態で鼻腔から経鼻チューブを挿入し固定しておく。

4）血管吻合

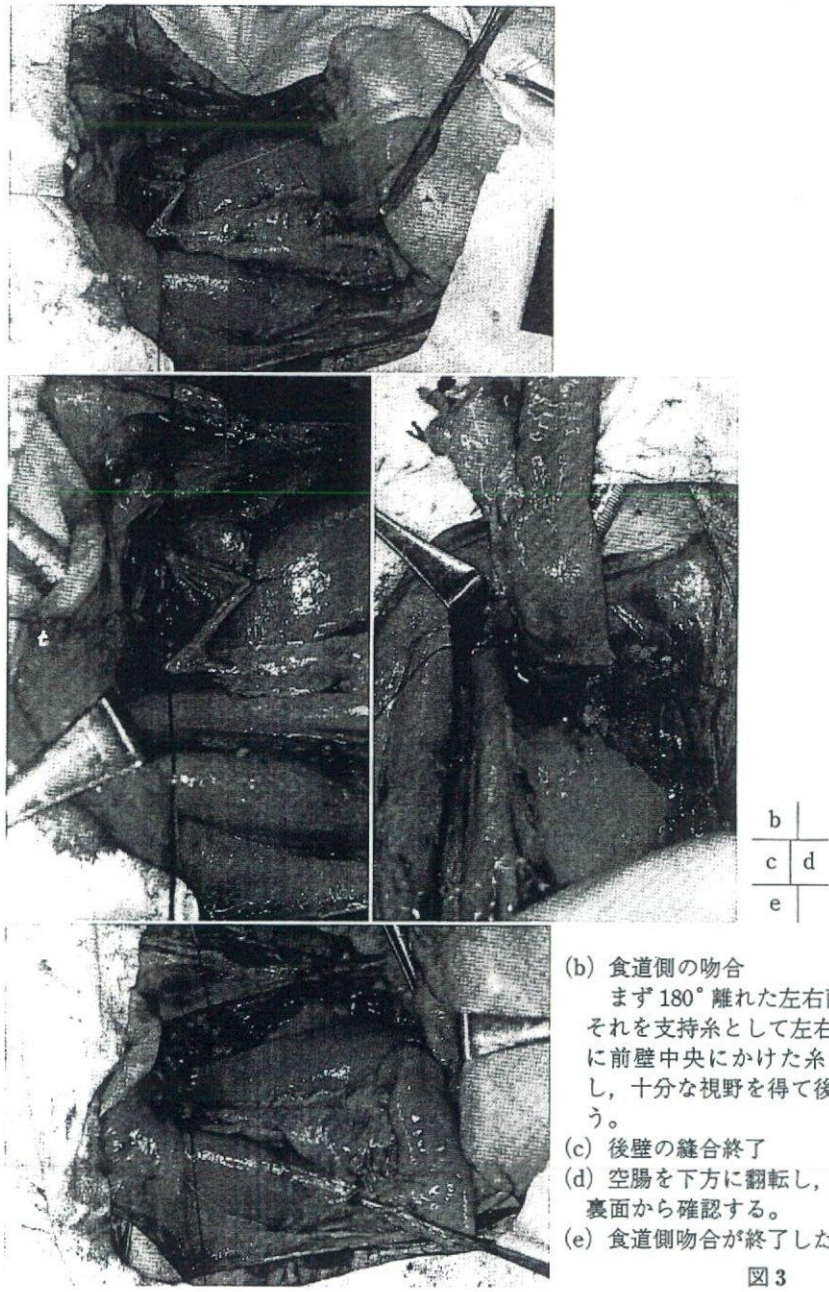
血管吻合に関しては，特別なことはなく，通常のfree flapと同様である。しかし，空腸は非常に血流の豊富な組織であるので，特に血管吻合後に断端などから出血がないかを確認しておく。外表ばかりでなく，縫合せずにおいた咽頭側前壁から内腔をも観察して，粘膜側からの出血がないことを確かめた後，開存する前壁面を縫合して固定を終了する（図4)。

3. 術後管理

移植空腸の術後モニタリングに関しては，腸間膜に島状に付着させた空腸の一部をあらかじめ頸部創から出しておき血行を確認する方法[10]や，頸部に空けた小切開創から空腸漿膜面を観察する方法[11]などが報告されている。しかし，前者ではモニター空腸片からの粘液流出や二次的な切離処置が煩わしく，後者では小切開では頸部浮腫の進行とともに判定が難しくなり，大きく開創すると感染や再縫合の必要が生じるなどの欠点がある。

われわれはもっぱら頸部皮膚面から当てたドップラー血流計でモニターしている。この場合主に動脈血の開存の判定を行うわけであるが，静脈の閉塞に関しては移植空腸の緊満や口腔内からの出血で容易にかつ比較的早期に判断できる。

安静に関しては，特に頸部の血管吻合部に



(b) 食道側の吻合
　まず180°離れた左右両端を縫合し，それを支持糸として左右に広げ，さらに前壁中央にかけた糸で上下に牽引し，十分な視野を得て後壁の縫合を行う。
(c) 後壁の縫合終了
(d) 空腸を下方に翻転し，後壁縫合部を裏面から確認する。
(e) 食道側吻合が終了した状態

図3

緊張がかかる場合を除き，術後3日を過ぎれば歩行を許可し早期離床を促していく。

経口摂取は，術後10日～2週で食道透視を行い，瘻孔などがないことを確認後に開始する（図5）。

III 合併症回避のための注意点

空腸移植とほかの皮弁・筋皮弁との縫合における最大の違いは，空腸壁が薄い組織であり，かつ血流に富む組織であるためより丁寧