Analysis of Fat Grafts for Stabilizing Microvascular Pedicle Geometry in Head and Neck Reconstruction

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Abstract

Background Even after careful microanastomosis, microsurgeons sometimes encounter unexpected twisting, kinking, and destabilizing mechanical forces. In these cases, a small fat graft is a useful technique for stabilizing the pedicle geometry in free flap transfer. However, few reports have provided the details with an analysis of fat graft use. The use of fat grafts for free flap transfer in head and neck reconstruction was reviewed.

Materials and Methods This was a retrospective review of 157 patients (116 men, 41 women; average ± SD age: 64 ± 13.1 years) who had undergone head and neck reconstruction with free flap transfer between 2010 and 2016. We used a fat graft to stabilize pedicle geometry to prevent kinking and other problems. Postoperative thrombosis formation and the use of a fat graft at the pedicle depending on recipient vessel selection and reconstructed site were examined.

Results In 23 patients (14.6%), fat grafting was performed to correct pedicle geometry. A fat graft was used at the arterial anastomosis in 13 patients and at the venous anastomosis in 10. There were no significant differences in postoperative thrombosis formation depending on the use of a fat graft. However, fat grafts were more likely to be performed with the superior thyroid artery as a recipient artery and in tongue and/or oral cavity reconstruction.

Conclusion A fat graft is a reliable and easy procedure to correct pedicle geometry. However, reconstructive surgeons should consider the use of a fat graft based on the selection of the recipient vessels and the recipient site.

Keywords
- microsurgery
- fat graft
- pedicle
- head and neck
- free flap

Although the use of free flap transfer has become standard for head and neck reconstruction, it is still difficult to achieve a 100% patency rate.[1–4] This is because success in free flap transfer needs not only the technique of microvascular anastomosis, but also proper orientation of the microvascular pedicle considering its three-dimensional geometry. Even after careful microanastomosis, microsurgeons sometimes encounter unexpected twisting, kinking, and destabilizing mechanical forces. These inappropriate geometries of the pedicle have a potential risk of flap failure.

Several authors have described the use of free fat grafts to achieve proper orientation of the pedicle and appropriate three-dimensional pedicle geometry.[5,6] Our experience and surgical techniques using fat grafts to stabilize the pedicle in

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head and neck reconstruction using a free flap transfer are described.

Materials and Methods

Characteristics

The study included 157 patients (116 men and 41 women, average ± SD age: 64 ± 13.1 years) who had undergone head and neck reconstruction using a free flap between January 2010 and June 2016. Of the 157 patients, 117 received head and neck free flap transfers at the Nagoya University Hospital and 40 received them at the Tottori University Hospital.

The areas involved were tongue and/or oral cavity in 42 (26.8%) patients, hypopharynx in 33 (21%) patients, mandible in 30 (19.1%) patients, mesopharynx in 22 (14%) patients, maxilla in 13 (8.3%) patients, face in 7 (4.5%) patients, and others in 10 (6.4%) patients. A free rectus abdominis musculocutaneous flap was used in 54 (34.4%) patients, a free anterolateral thigh flap in 41 (26.1%) patients, a free jejunal flap in 28 (17.8%) patients, a free fibular flap in 18 (11.5%) patients, a free forearm flap in 12 (7.6%) patients, a free latissimus dorsi musculocutaneous flap in 3 (1.9%) patients, and a free omental flap in 1 (0.6%) patient (►**Table 1**).

Surgical Procedure

After flap fixation to the defect and microanastomosis, autologous fat grafting was performed when there was unfavorable three-dimensional geometry of the pedicle. Autologous fat grafts were harvested from the subcutaneous tissue of the neck or a discarded flap with a size of 1 cm^3 (►**Fig. 1**). Adequate fat graft volumes were set to stabilize the pedicle at the proper position when there was kinking, an unfavorable angle between the recipient vessel and the flap pedicle, or some unexpected geometrical problems (►**Fig. 2**).

Descriptive statistics were calculated for each recipient vessel and recipient site. Postoperative thrombosis formation based on fat graft usage and the usage of fat grafts based on recipient vessel selection and the recipient site were analyzed. The reasons for using fat grafts in microanastomosis were also analyzed. All statistical analyses were performed using the chi-squared test or Fisher's exact test. Two-sided p-values < 0.05 were considered significant. Stat Flex version 6 (Artec Co. Ltd., Osaka, Japan) was used for all statistical analyses.

Fig. 1 A piece of fat graft harvested from the subcutaneous tissue of the neck or a discarded flap with a size of 1 cm^3.

Results

In all patients, single arterial anastomosis was performed. The superior thyroid artery was used as the recipient artery in 77 patients (49%), the transverse cervical artery was used in 58 (36.9%) patients, the facial artery was used in 16 (10.2%) patients, and the superficial temporal artery was used in 6 (3.8%) patients. With respect to venous anastomoses, double venous anastomosis was performed in 43 patients. The external jugular vein was used as a recipient vein in 89 (44.5%) patients, the internal jugular vein was used in 89 (44.5%) patients, the facial vein was used in 10 (5%) patients, the superficial temporal vein was used in 6 (3%) patients, the transverse cervical vein was used in 3 (1.5%) patients, the posterolateral cervical vein[7] was used in 2 (1%) patients, and the inferior thyroid vein was used in 1 (0.5%) patient.

In 23 of 157 patients, fat grafts were performed at microanastomosis. In one patient who had not received a fat graft

Table 1 Patient summary (reconstructed area and free flap used for reconstruction)

	Rectus abdominis	Anterolateral thigh	Jejunum	Fibula	Forearm	Latissimus dorsi	Omentum	
Tongue, oral cavity	17	25						42 (26.8%)
Hypopharynx	1		26		6			33 (21%)
Mandible	10	1		18		1		30 (19.1%)
Mesopharynx	5	14	2			1		22 (14%)
Maxilla	13							13 (8.3%)
Face	2				5			7 (4.5%)
Others	6	1			1	1	1	10 (6.4%)
Total	54 (34.4%)	41 (26.1%)	28 (17.8%)	18 (11.5%)	12 (7.6%)	3 (1.9%)	1 (0.6%)	157

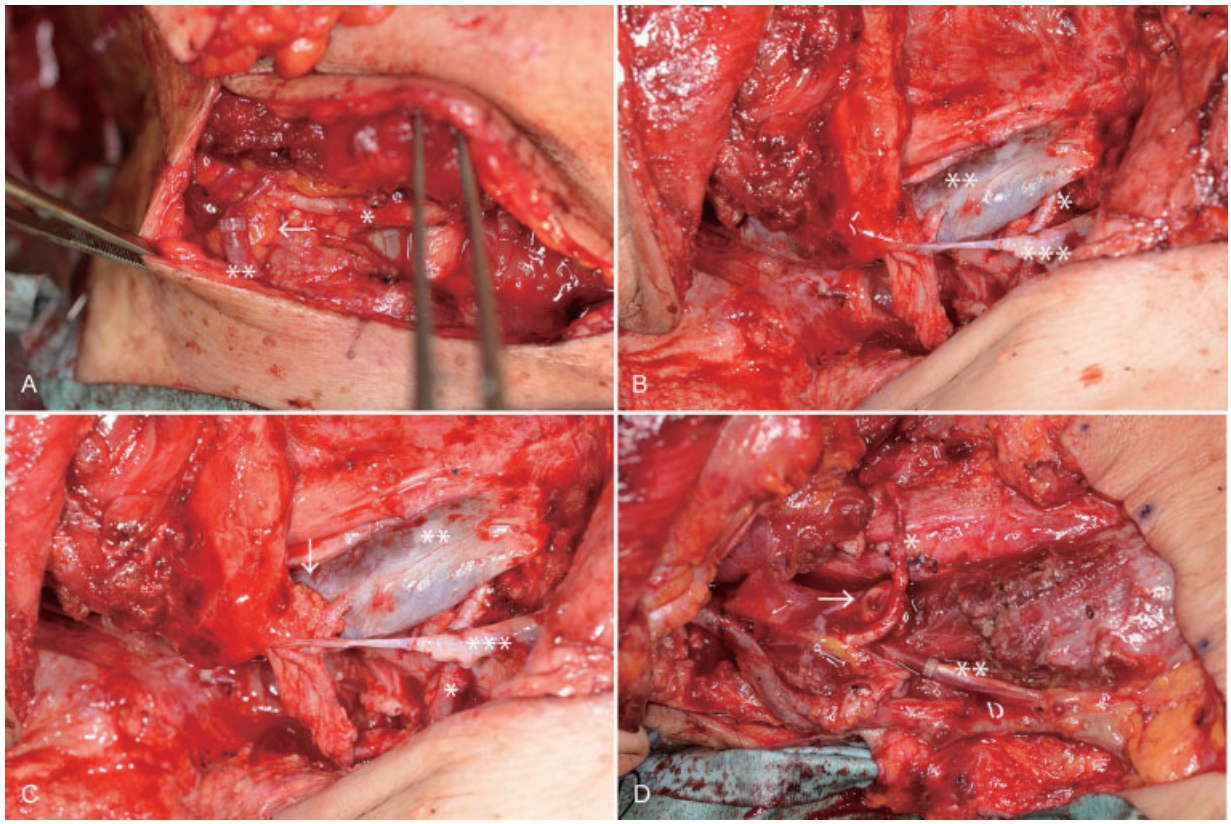

Fig. 2 (**A**) Intraoperative view of head and neck reconstruction with a rectus abdominis musculocutaneous flap after resection of external auditory meatus cancer. The recipient artery is the facial artery (*), and the recipient vein is the external jugular vein (**). The kinking of the external jugular vein is corrected by a fat graft (arrow). (**B**) Intraoperative view of mandibular reconstruction with a fibular flap after resection of left gingival cancer. The recipient artery is the superior thyroid artery (*), and the recipient veins are the internal jugular vein (**) and the external jugular vein (***). The kinking of the superior thyroid artery is corrected by a fat graft (arrow). (**C**) Intraoperative view of tongue reconstruction with an anterolateral thigh flap after right hemiglossectomy (left). The recipient artery is the transverse cervical artery (*). The recipient veins are the internal jugular vein (**) and the external jugular vein (***). A fat graft is used to correct the unfavorable angle between the flap vein and the internal jugular vein (right, arrow). (**D**) Intraoperative view of mesopharyngeal reconstruction with an anterolateral thigh flap. The recipient artery is the superior thyroid artery (*), and the recipient vein is the external jugular vein (**). A fat graft is put under the arterial anastomosis to prevent pressure on the venous anastomosis (arrow).

at microanastomosis, venous thrombosis occurred. The total patency rate was 99.4%. There was no significant difference in thrombosis formation between the fat graft (+) group and fat graft (−) group.

Fat grafts at the arterial anastomosis were performed in eight patients who underwent tongue or oral cavity reconstruction, two patients who underwent mandibular reconstruction, one patient who underwent mesopharyngeal reconstruction, one patient who underwent maxillary reconstruction, and one patient who underwent other reconstruction. There was a significant difference in the tongue or oral cavity reconstruction group in the use of fat grafts at arterial anastomosis ($p = 0.001$). Fat grafts at venous anastomosis were performed in three patients who underwent tongue or oral cavity reconstruction, four patients who underwent hypopharyngeal reconstruction, one patient who underwent mandibular reconstruction, and two patients who underwent other reconstructions. There were no significant differences among the reconstruction groups in the use of fat grafts at venous anastomosis.

Fat grafts were performed in 11 patients whose recipient artery was the superior thyroid artery, 1 patient whose recipient artery was the facial artery, and 1 patient whose recipient artery was the transverse cervical artery. There was a significant difference in the use of fat grafts between the superior thyroid artery and other recipient arteries ($p = 0.003$). Fat grafts were performed in three patients whose recipient vein was the external jugular vein and in seven patients whose recipient vein was the internal jugular vein. There was no significant difference in the use of fat grafts at venous anastomosis among the recipient veins (►**Table 2**).

Of 13 arterial anastomoses, the reasons for fat grafting were to prevent kinking in 10 and pressure on venous anastomosis in 3. Of 10 venous anastomoses, the reasons for fat grafting were to correct the angle between the flap vein and the internal jugular vein in 7 and prevent kinking in 3 (►**Table 3**).

Discussion

Ideally, the artery and vein of the pedicle should run in the same or similar axes to prevent kinking in head and neck reconstructive microsurgery.[5,6,8,9] However, the selection of the

Table 2 Summary of fat graft use

			[a]Tongue, oral cavity	Hypopharynx	Mandible	Mesopharynx	Maxilla	Face	Others
Recipient artery	[b]Superior thyroid artery	77 (11)	30 (7)	5	23 (2)	10 (1)	3	3	3 (1)
	Transverse cervical artery	58 (1)	12 (1)	28	5	11		1	1
	Facial artery	16 (1)			2	1	9 (1)	1	3
	Superficial temporal artery	6					1	2	3
Total		157 (13)	42 (8)	33	30 (2)	22 (1)	13 (1)	7	10 (1)
			Tongue, oral cavity	**Hypopharynx**	**Mandible**	**Mesopharynx**	**Maxilla**	**Face**	**Others**
Recipient vein	External jugular vein	89 (3)	29	8 (1)	23 (1)	14	5	5	5 (1)
	Internal jugular vein	89 (7)	25 (3)	27 (3)	22	12		1	2 (1)
	Facial vein	10	1			1	7		1
	Superficial temporal vein	6					1	2	3
	Transverse cervical vein	3	2		1				
	Posterolateral cervical vein	2	1		1				
	Inferior thyroid vein	1	1						
Total		200 (10)	59 (3)	35 (4)	47 (1)	27	13	8	11 (2)

Note: Numbers in parentheses are number of patients who received fat grafts.
[a]$p = 0.001$.
[b]$p = 0.003$.

recipient vessels usually depends on the range of neck dissection.[10,11] Therefore, there are some limitations in arranging pedicle geometry because of the relationship between the defect and recipient vessels. We suppose that even very experienced microsurgeons can face unexpected pedicle geometry after microanastomosis in head and neck reconstruction.

Fat grafting is a reliable, easy, and time-saving technique for stabilizing the microvascular geometry to prevent complications including postoperative thrombosis formation. Bar-Meir et al[5] first reported the use of a fat graft for stabilization of the microvascular pedicle in breast reconstruction using a deep inferior epigastric perforator (DIEP) flap. They used the internal mammary vessels as recipient vessels and fat grafts in all patients. They used the fat graft as a cushion. The vessels were present in the rib space and interfered with the anastomotic site. The firm chest wall surrounding the pedicle may compress the vein if it traverses over the rib. We also use fat grafts to prevent compression between arteries and veins. Pedicle vessels sometimes cross each other because of the selection of the recipient vessels. They reported that the fat grafts remained in the original position where they were placed after 72 hours. Transferred fat grafts may be absorbed, but postoperative thrombosis often occurs within 72 hours.[3] Therefore, the presence of a fat graft for at least 72 hours does not affect postoperative complications.

Table 3 Reasons for using fat grafts at anastomosis ($n = 23$)

Artery ($n = 13$)			
Preventing kinking		Preventing pressure	
Superior thyroid artery	Facial artery	Superior thyroid artery	Transverse cervical artery
9	1	2	1
Vein ($n = 10$)			
Correcting angle		Preventing kinking	
Internal jugular vein		External jugular vein	
7		3	

Sader et al[6] reported the use of fat grafts for stabilizing microvascular pedicles in head and neck reconstruction. They used fat grafts in 52 pedicles of 227 head- and neck-free tissue transfers. They used fat grafts more frequently than we did to prevent kinking or compression. We presume that the use of fat grafts depends mainly on the surgeon's individual experience and preference.

It is more likely that a fat graft will be used at the superior thyroid artery in the tongue or oral cavity reconstruction.

In these patients, we selected the superior thyroid artery as the recipient artery, when the sternocleidomastoid that would be an obstacle to microanastomosis was preserved after neck dissection. The superior thyroid artery emerges from the external carotid artery and runs down to the thyroid. When the superior thyroid artery is selected as the recipient artery, the direction of the artery should be changed to be cephalad in tongue or oral cavity reconstruction. Despite appropriate care, making an ideal curve of the pedicle is sometimes difficult after microanastomosis, and a fat graft can be used to arrange pedicle geometry to prevent kinking.

There were no significant differences in fat grafts in venous anastomosis because we could perform venous microanastomosis on a favorable part of the internal jugular vein between the clavicles and the lower border of the mandible, irrespective of the type of recipient artery. However, the distance between the defect and the internal jugular vein is short for the pedicle length of a free flap. Microanastomosis must be performed in a narrow space when the sternocleidomastoid muscle is preserved after neck dissection. This sometimes leads to the flap vein and the internal jugular vein making unfavorable angles. In these cases, we usually place the fat graft between the flap vein and the internal jugular vein to create a proper angle.

Conclusion

An analysis of our use of fat grafts to stabilize microvascular pedicle geometry in head and neck reconstruction was presented. Microsurgeons should consider the use of fat grafts based on the situation. This may support microsurgeons when they face unexpected pedicle geometry after microanastomosis.

Conflict of Interest
None.

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