Postoperative outcomes of free myocutaneous flap and pedicled myocutaneous flap for reconstruction in locally invasive thyroid carcinoma

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Abstract

Locally invasive thyroid carcinoma (TC) often involves trachea. In such patients, the trachea needs to be reconstructed after surgery. We discuss the postoperative outcome and complications after trachea reconstruction by free myocutaneous flap (FMF) and pedicled myocutaneous flap (PMF).

From January 2009 to September 2019, the clinical data of 38 patients with TC were retrospectively analyzed. Demographics, pathologic results, neoplasm staging, surgical protocol, decannulation, subjective speech function, and complications were documented.

A total of 38 patients were analyzed (22 FMFs and 16 PMFs). Of the 38 patients, there is a similar rate of decannulation (81.8% in FMF and 75% in PMF), subjective speech function and complications.

The FMF reconstruction and the PMF reconstruction have a similar result in terms of postoperative outcome and complications.

Abbreviations: DTC = differentiated thyroid carcinoma, FMF = free myocutaneous flap, PMF = pedicled myocutaneous flap, RLN = recurrent laryngeal nerve, TC = thyroid carcinoma.

Keywords: thyroid carcinoma, locally invasive, trachea reconstruction, free myocutaneous flap, pedicled myocutaneous flap, outcome

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1. Introduction

Thyroid carcinoma (TC) is the most common malignant tumor of the head and neck. In recent years, the incidence of thyroid carcinoma has increased worldwide, namely the growth averaged at 3.1% each year.[1] Differentiated thyroid carcinoma (DTC) takes up a vast proportion of all TC which is approximately 90%.[2] As well, DTC exhibits aggressive medical behavior as a result of extrathyroidal spread. Locally invasive disease involves not only the muscles, nerves, and trachea, but can also affect larynx, pharynx, esophagus, and major vessels.[3] Fifty percent of patients eventually die of asphyxiation and significant hemoptysis rather than tumor itself.[4–6] Therefore, patients often require more aggressive and effective surgery to remove the tumor and the trachea.[7] However, there is a complex surgical decision-making on how to take both the preservation of upper aerodigestive track head and neck function and the complete removal of the primary tumor into account.[8] Namely, tracheal reconstruction poses a major challenge for head and neck surgeons.

The goals of tracheal reconstruction is to provide a rigid structure to maintain an open lumen, achieve an intact luminal lining, and restore tracheal function in clearing secretions.[9] Over the years, head and neck surgeons have endeavored varieties of methods to reconstruct the tracheal defect to get desired better survival prognosis and living quality, such as autologous cartilage graft,[10] tracheal end-to-end anastomosis,[11] free myocutaneous flap (FMF),[7] and pedicled myocutaneous flap (PMF).[12] However, there is no consensus about the optimal option of defect reconstruction. Considering the large defect after tumor resection, autologous cartilage graft and end-to-end

anastomosis are generally not applicable to tumor patients. The most common reconstruction for head and neck tumor surgery are FMF and PMF. Both of these reconstruction methods leave a heavy mark on the defect repair and functional reconstruction after head and neck tumor resection.

Here, we presented our clinical experience of using FMF and PMF for tracheal reconstruction after tumor resection in patients with locally invasive DTC invading trachea. By analyzing the relevant data, the postoperative outcomes and complications were compared in this paper.

2. Materials and methods

2.1. Patients

Between January 2009 and September 2019, a total of 38 patients with DTC invading tracheal were admitted to Department of Otorhinolaryngology, Head and Neck Surgery, West China Hospital of Sichuan University (preoperative acupuncture cytological examination or previous operative paraffin section). Endoscope examinations were applied to preoperative evaluation for the mucosa and the invasion of pharynx, larynx, trachea, and esophagus (in case of suspicion). Computed tomography or magnetic resonance image was performed to evaluate the size of the tumor, the depth of invasion, as well the vessel and muscle involvement.

All operations were performed by an experienced medical team. The TNM classification was in line with the American Joint Committee on Cancer (2017). Informed consent was obtained from all patients. Approval from the Institutional Review Board of the West China Hospital of Sichuan University was obtained before this study was performed.

2.2. Operation

All patients underwent radical tumor resection which was defined as resection of penetrated area of the tracheal lumen, namely window resection. According to the depth of tumor infiltration of the esophagus, the choice was to perform muscle layer resection or esophageal reconstruction. At least unilateral recurrent laryngeal nerve (RLN) should be preserved as much as possible. If bilateral were damaged, the unilateral RLN reconstruction was of necessity. Cartilage resection was performed when tumor infiltration did not reach the inner thyroid cartilage lamina and cricoid cartilage lamina. Framework resection, such as partial laryngectomy, total laryngectomy, and partial hypopharyngectomy resection, was performed when tumor infiltration reached or intraluminal invasion of the larynx and hypopharynx. Multiple surgical margins were negative proved by intraoperative frozen pathology. The suitable FMF or PMF was selected for reconstruction of the large defect. The flap was half rolled and sutured with residual negative tracheal tissue. Then the flap edge was directly sutured with skin to form a tracheal fistula, and the tracheal cannula was placed into the fistula. Two-staged operations for the stomal closure or reconstruction by deltopectoral flap under appropriate conditions.

All patients had nasogastric tubes placed and received nutritional care provided by professional nutritionists. All patients received conventional wound care, air management, acid-suppressive drugs and anti-inflammatory drugs. Their flaps were monitored by electronic laryngoscopy postoperatively.

2.3. Follow-up

Periodic follow-up was conducted to inspect whether locoregional or distant recurrence including laryngoscopy and CT. Follow-up time was calculated from the moment of surgery to the last clinical visit. Subjective speech function was selected by patients themselves. Speech function was divided into 3 grades including normal, slightly worse and poor. Normal: no effect on daily communication; slightly worse: a moderate effect on daily communication; poor: serious impact on daily communication.

2.4. Statistics analyses

Groups were compared using the Mann–Whitney U test, Chi-Squared test or independent sample t test, as appropriate. Bivariate logistic regressions were used to compare surgical outcomes and postoperative complications between 2 groups. A P value of $<.05$ was considered statistically significant. All statistical analyses were performed using SPSS version 24.0.

3. Results

3.1. Patients' characteristics

Table 1 provides a comprehensive breakdown of 38 patients by type of flap reconstruction. A total of 22 patients underwent reconstruction with an FMF and 16 with a PMF. The mean age was 56.58 years (range 20–75 years), with 65.8% women. One of them considered dedifferentiation into undifferentiated carcinoma, which differs from the type before the surgery. No differences were observed between the 2 groups in terms of age, gender, prior

Table 1

Patients' characteristics.

	FMF	PMF	*P* value
Patients Number (*N*)	22	16	
Age, years	53.86 ± 15.39	60.31 ± 9.67	.149
Gender			.290
Male	6 (27.3%)	7 (43.7%)	
Female	16 (72.7%)	9 (56.3%)	
Prior surgery	4 (18.2%)	6 (37.5%)	.182
Pathological type			.151
Papillary carcinoma	14 (63.6%)	13 (81.3%)	
Follicular carcinoma	8 (36.4%)	2 (12.5%)	
Undifferentiated cancer	0	1 (6.3%)	
Iodine-131 therapy	19 (86.4%)	13 (81.3%)	.670
Concurrent neck dissection			.353
None	2 (9.1%)	3 (18.8%)	
Unilateral	4 (18.2%)	5 (31.3%)	
Bilateral	16 (72.7%)	8 (50%)	
Defect length (rings)			.374
1–4	5 (22.7%)	7 (43.7%)	
5–8	14 (63.6%)	7 (43.7%)	
≥9	3 (13.6%)	2 (12.5%)	
Defect width (circle)			.169
≤50%	17 (77.3%)	15 (93.7%)	
>50%	5 (22.7%)	1 (6.3%)	
Staging			.935
I	6 (27.3%)	3 (18.8%)	
III	9 (40.9%)	7 (43.7%)	
IVA	5 (22.7%)	4 (25%)	
IVB	2 (9.1%)	2 (12.5%)	

FMF = free myocutaneous flap, PMF = pedicled myocutaneous flap.

Table 2
The structure involved by TC.

	FMF	PMF	P value
Trachea			
Intraluminal	8 (36.4%)	5 (31.3%)	.213
Larynx			
Intra-larynx	2 (9.1%)	1 (6.3%)	.505
Thyroid cartilage	3 (13.6%)	4 (25%)	.739
Cricoid cartilage	6 (27.3%)	7 (43.7%)	.833
Esophagus	1 (4.5%)	6 (37.5%)	.124
Piriform	1 (4.5%)	1 (6.3%)	.962
Vascular	3 (13.6%)	4 (25%)	.739
RLN			.949
Unilateral	12 (54.5%)	8 (50%)	
Bilateral	1 (4.5%)	1 (6.3%)	

TC = thyroid carcinoma, FMF = free myocutaneous flap, PMF = pedicled myocutaneous flap, RLN = recurrent laryngeal nerve.

surgery, pathological type, iodine-131 therapy, concurrent neck dissection, defect length, defect width, or staging.

The structures involved are listed in Table 2. All of the patients' tumors had involved the trachea, whereas 8 had invasion of esophageal. Thirteen patients had tracheal intraluminal involvement. Seven patients' thyroid cartilage had invasion and 13 patients' cricoid cartilage did. Even tumors invaded the larynx in 3 patients. Two patients' piriform fossae were invaded. Twenty patients' unilateral RLNs were resection. The other 2 patients' RLNs were reconstructed through the cervical plexus because of bilateral involvement

3.2. Surgical outcomes

Surgical outcomes are detailed in Table 3. There was no significant difference between the 2 surgical reconstruction methods when considering decannulation, subjective speech function and phlegm. 81.8% of patients in the FMF group and 75% of patients in the PMF group get decannulation. And the total decannulation rate is 78.9%.

3.3. Complications

Postoperative complications are listed in Table 4. There was no significant difference in recipient or donor site complications between the 2 groups. Only 2 patients showed cold intolerance of the distal limb in the FMF group. The total flap complication rate

Table 3
Surgical outcomes.

	FMF	PMF	P value	P value*	OR (95% CI)
Postoperative decannulation	18 (81.8%)	12 (75%)	.611	.696	0.721 (0.139–3.729)
Subjective speech function#			.248	.268	0.459 (0.116–1.821)
Normal	11 (50%)	5 (31.3%)			
Slightly worse	9 (40.9%)	5 (31.3%)			
Poor	2 (9.1%)	6 (37.5%)			
Phlegm complaint	14 (63.6%)	9 (56.3%)	.646	.545	1.526 (0.388–6.002)

* Based on bivariate logistic regression.
# Slightly worse and poor speech function were combined to be compared to normal speech function.
FMF = free myocutaneous flap, PMF = pedicled myocutaneous flap, OR = odd ratio.

Table 4
Complications.

	FMF	PMF	P value	P value*
Recipient site				
Fistula	2 (9.1%)	3 (18.8%)	.384	.324
Hemorrhage	1 (4.5%)	1 (6.3%)	.816	.706
Flap necrosis	1 (9.1%)	2 (12.5%)	.369	.190
Donor site				
Minor infection	2 (9.1%)	2 (12.5%)	.735	.838
Cold intolerance#	2 (9.1%)	NA	NA	NA
Hypoproteinemia	6 (27.3%)	7 (43.7%)	.290	.719
Pulmonary infection	3 (13.6%)	6 (37.5%)	.088	.102

* Based on bivariate logistic regression.
# Cold intolerance means patients' sensation of donor site.
FMF = free myocutaneous flap, PMF = pedicled myocutaneous flap, NA = not applicable.

is 18.2% in the FMF group and 37.5% in the PMF group. With conservative treatment, all of these complications were healed within 3 weeks. During the hospitalization period, the overall flaps' survival rate was 100%.

3.4. Oncological outcome

The patients in this study were followed up for 8 to 100 months, and the median follow-up time was 40 months. In the FMF group, 1 patient with papillary carcinoma died of entity recurrence as undifferentiated carcinoma 4 years after surgery. In the PMF group, 1 patient died of pulmonary metastasis 4 months after surgery. One patient in the FMF group and 2 patients in the PMF group had cervical node metastasis after surgery and survived without tumor after cervical lymph node dissection. All the remaining patients survived without tumor.

4. Discussion

For head and neck surgeons, the management of DTC extrathyroidal extension with tracheal invasion has always been a major problem. It has been reported that complete tracheal tumor resection can improve the survival rate of patients.[13] Current methods of tracheal resection include shave resection, window resection,[14] and segmental resection.[15] Moritani reported that window resection can decrease the incidence of locoregional recurrence.[16] Furthermore, segmental resection results in higher rate of complications including anastomotic dehiscence, laryngeal stenosis.[17] Therefore, in our series, all patients underwent radical tumor resection plus tracheal window resection.

Postoperative tracheal defect reconstruction, not only for survival, but also for functional and aesthetic requirements, is particularly of importance. In addition, the upper way is not a conductive environment for wound healing because of the constant bacterial contamination, limited vascularity, and the constant desiccation from breathing.[18] These requirements make us to be more meticulous about tracheal reconstruction and materials selection. Numerous materials for tracheal reconstruction have been stated above. However, more or less have their own shortcomings. In our series, patients had undergone enlarged neck dissection and strap muscles resection. The surrounding residuum tissue was insufficient to provide an adequate blood supply to the graft. Meanwhile, on account of the extensive surrounding structure invaded by tumor, the large

tissue of vascularized autologous material become a necessity for reconstruction. The flap technique is well-known in head and neck reconstruction, which provides nonirradiated and well vascularized tissue, offering adequate protection against fatal complications.[19] However, few literatures have compared the functional outcome between different flaps. In view of this, we conducted this retrospective cohort study.

PMF has been favored by head and neck surgeons for its flexible design, easy harvest, constant vascular configuration, abundant blood supply, and considerable reliability. Besides, PMF can effectively reduce the operative time and patients' cost.[20,21] Another PMF's merit is that the surgeon does not need to master microsurgical experience. Moreover, PMF can be used as a salvage decision for postoperative complications.[9] And yet, the pedicle must be adjacent to the recipient site which carries a risk of lymphatic drainage and donor site sometimes can not avoid aesthetic deformity and functional dysfunction. These concerns make PMF less versatile. With the continuous maturation of microvascular technology, more and more free flaps can be used clinically due to their advantages. Because of the different structure invaded by DTC, the defect appears irregular. Correspondingly, FMF which is used for reconstruction can also be tailored to the defect. Similarly, the tissue volume of FMF can be modified to the defect. On the other hand, the donor site is concealed and away from the tumor, which is more in line with the principles of tumor-free surgery. However, FMF still has its shortcoming, that is, the necessity of skin graft of donor site[22] and possible existence of cold intolerance in the distal limb.

Making the right surgical decision is critical, and the patients' outcomes are of importance. Flap reconstruction may complicate wound healing and cause fistula, hemorrhage, necrosis, and dehiscence.[23] It may further aggravate the formation of stenosis and prolong dependence of gastric tube. These conditions not only increase the cost and time in the hospital, but also cause hidden psychological damage to patients. Khan reported that 30% of fistulas occurred with PMF reconstruction.[19] In our series, we did not observe any significant difference in complications between 2 groups. But the incidence of complications was slightly higher in the PMF group than the FMF group. We speculated that this result might have something to do with potential damage near the surgical area in the PMF group. However, it is worth noting that all complications were successfully recovered by conservative treatment in 3 weeks, such as strict dressing change to fistula, application of enoxaparin local therapy, or exsanguination via stab incision to flap necrosis.

Tracheostomy is a surgical procedure performed at the time of head and neck cancer resection and tissue transfer reconstruction as a temporary airway.[24] But it may result in difficulty in the passage of the food bolus, increased occurrence of stasis in the supraglottic region, decreased airway protection, and phlegm deposition. In addition, it can seriously reduce the quality of speech. Therefore, 2-staged decannulation after strict evaluation is a positive operation for patients, which can reduce tracheostomy-related complications and ease the economic burden of stoma care. In the present study, no statistical difference was found for decannulation, which could be explained by the sufficient blood supply for early vascularization and mucosalization of flaps. Meanwhile, strict implementation of indications is also one of the important conditions for successful decannulation.

However, there are few reports on speech evaluation after tracheal reconstruction. The main reason may be a lack of objective measurement. Patients' speech function is related to RLN, the framework of larynx and pharynx and closed trachea. We found that the speech functional outcome in the 2 groups was similar when there was no difference in related factors. However, our lack of research in this area is also very obvious. This subjective speech function is not optimal to obtain the information of the precise quality of phonation. Besides, we did not focus on the swallow function. The quality of swallow is also of importance for the patients' quality of life. View of that, our future prospective studies should record more relevant data.

5. Conclusion

It is feasible and necessary to use myocutaneous flaps to reconstruction the huge defect of trachea after locally invasive TC surgery. In our cohort, FMF and PMF had a similar rate of postoperative complications. Furthermore, decannulation and subjective speech function were also similar in both groups. In our future studies, on the one hand, there is a necessary protocol that makes a model of relevant factors of 2-staged decannulation after tracheal surgery. On the other hand, objective assessment of phonation and swallow indicators will be recorded in detail. Our future studies will continue to move in this direction.

Author contributions

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