

Pectoralis major flap reconstruction in the prevention of wound breakdown and fistula formation after salvage laryngectomy: a controlled study

Reda M. Sabra, Mohamed S. Taha, Tarek A. Hamdy, Hossam Rabie, Magdy A. Riad

Eldemerdash Hospital, Faculty of Medicine, Ain-Shams University, Cairo, Egypt

Correspondence to Reda M. Sabra, MD, 71 Imtidad Walley Elahd Hadayek Elkoppa, Cairo, Egypt
Tel: +20 109 865 3808;
e-mail: redasabra@yahoo.com

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Background

Patients undergoing salvage laryngeal surgery after high-dose radiotherapy or concurrent chemotherapy/radiation therapy regimen are more prone to develop pharyngocutaneous fistulas (PCFs). The fistula rates reported are as high as 70%.

Aim of the study

The aim of this study was to assess the effectiveness of pectoralis major muscle flap (PMF) in prevention of fistula formation and in enhancing wound healing in patients undergoing salvage laryngectomy.

Patients and methods

We compared results from patients of salvage laryngectomy repaired with pectoralis major flap with those of a similar group repaired by primary wound closure in 36 consecutive patients. Group A included 16 patients who underwent PMF following salvage total laryngectomy (12 male and four female patients; median age 56 years; interquartile range, 49.8–61.8). The other group included 20 patients who underwent primary closure of the wound without PMF (group B) (15 male and five female patients; median age 43 years; interquartile range, 36–54). Minimum follow-up in both groups was 3 months.

Results

The incidence of PCF in group A was 6.2% and that of wound gap was 6.2%, and there was no carotid blowout. The results in group B were as follows: 60% PCF rate and poor wound healing with gapping in 40% of patients and carotid blowout in 25% of patients ($P < 0.001$). The mean duration to fistula closure was 20 days in group A compared with 57.5 days in group B.

Conclusion

Pectoralis major flap will give the patients the advantages of less fistula formation, good wound healing, early oral feeding, short hospital stay and protection against catastrophic vascular blowouts.

Keywords:

fistula, flaps, laryngectomy, pectoralis major, reconstruction

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Introduction

Laryngectomy is used increasingly as a salvage procedure after radiotherapy or chemoradiotherapy. The development of organ preservation protocols and primary chemoradiotherapy for patients with advanced laryngeal cancer resulted in an organ preservation rate of 64% and survival rates similar to those seen in patients offered laryngectomy followed by radiotherapy [1].

Patients undergoing salvage surgery are more prone to develop pharyngocutaneous fistulas (PCFs) because of injuries to the tissue microvasculature, resulting in myointimal fibrosis, endarteritis and worsening of atherosclerosis, which lead to a hypovascular, hypocellular and hypoxic environment, reducing healing capacity and increasing the risk for fistula formation to as high as 70% [2]. In an attempt to prevent or reduce

the incidence of salivary fistulas, some authors have advocated the routine use of nonirradiated flaps to reduce the morbidities associated with salivary fistulas in salvage laryngectomy patients, even when there is enough mucosa for a primary closure procedure.

Placement of a vascularized tissue that was out of the field of radiation may improve the healing capacity in such settings [3]. In this article, we assess the effectiveness of pectoralis major muscle flap (PMF) in wound healing, protection against catastrophic vascular blowouts and prevention of fistula formation after salvage laryngectomy.

Patients and methods

This is a retrospective study. It was conducted at the Otorhinolaryngology Department, Ain Shams

University Hospitals, between January 2011 and October 2014 with Institutional Review Board approval. An informed written consent was obtained from all participants.

Thirty-six patients were enrolled in our study. All of them were diagnosed with T3 or T4 squamous cell carcinoma of the larynx. Eligibility criteria for this study included patients undergoing salvage total laryngectomy following failed attempts in organ preservation protocols with either high-dose radiotherapy or concurrent chemotherapy/radiation therapy regimen. The series consisted of 36 consecutive patients were divided into two groups: group A and group B. Group A included 16 consecutive patients (12 male and four female patients; median age 56 years; interquartile range, 49.8–61.8) who underwent PMF following salvage total laryngectomy. Group B consisted of 20 patients who underwent concomitant chemoradiotherapy and met the same eligibility criteria (15 male and five female patients; median age 43 years, interquartile range, 36–54) (Table 1). They underwent primary closure of the wound without PMF.

Minimum follow-up in both groups was 3 months. Student's *t*-test was used in statistical analysis. Skewed numerical data are presented as median and interquartile range. Qualitative data are presented as number and percentage.

Surgical technique [4]

Total laryngectomy with or without neck dissection are performed in the standard way, taking extra care to preserve branches of the superior and inferior thyroid vessels supplying the residual pharyngeal tissues. Care is also taken to clear the field from any devitalized tissues and secure haemostasis. A primary tracheo-oesophageal puncture is created at this stage, because of the difficulties in performing a secondary puncture once the PMF overlies the neopharynx.

A size 14–18-feeding tube is inserted through the tracheo-oesophageal puncture to avoid any pressure on the pharyngoplasty suture line. Pharyngoplasty is

then carried out in three layers: first by meticulous suturing and inverting the mucosal edges using 3-0 vicryl extraluminal sutures, followed by enforcing the repair by suturing the overlying buccopharyngeal fascia, and finally by suturing the cut edges of the thyropharyngeus and cricopharyngeus muscles over the repaired pharynx. The neck wound is then covered with swabs soaked in normal saline, and the anterior thoracic wall is prepared for harvesting the PMF.

The surgical technique we used aimed at harvesting two large pedicled flaps: the deltopectoral skin flap and a fasciomuscular pectoralis major flap. The skin flap is resutured to its bed, to be used later only if there is a major wound breakdown, and the PMF is mobilized to cover the pharyngoplasty and major neck vessels (Figs. 1 and 2). The skin and fascia are then elevated off the muscle by means of a sharp dissection, taking care not to injure the perforating intercostal branches from the internal mammary vessel that supplies the skin flap.

The exposed pectoralis major muscle is then dissected off the thoracic wall by means of a sharp dissection; branches from the lateral thoracic artery may have to be divided to allow the pedicle length of the PMF to reach the upper neck defect. While harvesting the PMF, the inferior border of the muscle is first incised, and dissection is carried out to lift the muscle off the thoracic wall. Identification of the pectoral branch of the thoracoacromial artery is the crucial step during the procedure. The vessels should be identified on the undersurface of the muscle before any further muscle incisions are carried out. Muscle cuts are then made lateral and medial to the exposed vascular pedicle (Fig. 3). The mobilized muscle flap can now be turned over to cover the neck wound while the vascular pedicle is under clear vision (Fig. 4).

Figure 1



The deltopectoral skin flap.

Table 1 Patients groups

Variable	Group A with PMF	Group B without PMF
Number	16 (44)	20 (56)
Age	43 (36–54)	56 (49–61)
Sex	12M, 4F	15M, 5F
Chemoradiotherapy	+	+
T stage		
T3	12	15
T4	4	5

Data are represented as percentage (number) and median (age); PMF, pectoralis major muscle flap.

Care must be taken to ensure that the flap is not under any tension in its new position in the neck. Strict haemostasis is secured in the thoracic wound. The deltopectoral skin flap is then returned to its original position and sutured in two layers. The PMF is now used to cover the neopharynx, the carotid sheaths and the supratracheostomy region. Nonabsorbable sutures are used to secure the PMF in the neck; the wound is irrigated and suction drains are inserted.

Results

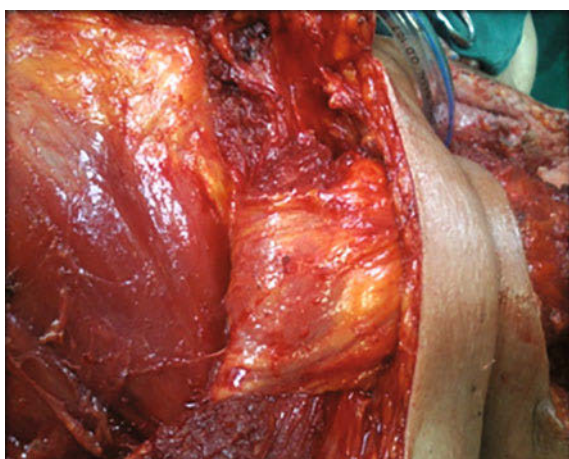
A total of 36 consecutive patients were included in this study. The results are summarized in Table 2. The incidence of PCF was 6.2% for salvage surgery patients with PMF reinforcement, whereas it reached 60% for patients who underwent salvage surgery without PMF reinforcement ($P < 0.001$). The mean duration to final healing and oral feeding was 22.5 days in group A compared with 51.8 days in group B.

Figure 2



Deltopectoral flap elevated to expose the pectoralis major muscle.

Figure 4



Pectoralis muscle turned in the neck.

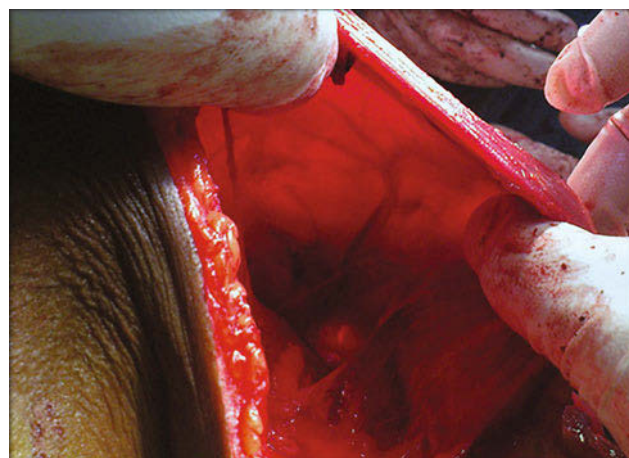
There was poor wound healing with gapping in 40% of patients and carotid blowout in 25% of patients in group B, compared with group A in which wound gap was seen in 6.2% of patients and there was no incidence of carotid blowout. There was only one case of flap failure in group A (Fig. 5).

There was early oral feeding and shorter hospital stay (average 3 weeks) in group A compared with late oral feeding and longer hospital stay (more than 9 weeks) in group B ($P < 0.001$) (Table 2).

Discussion

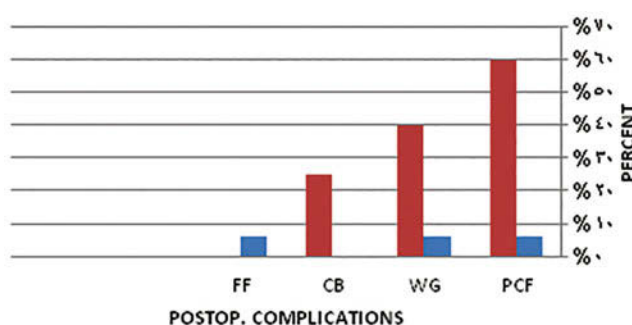
Total laryngectomy following radiation therapy or concurrent chemoradiation therapy is associated with unacceptably high complication rates because of wound healing difficulties. With an ever increasing reliance on organ preservation protocols as primary treatment for advanced laryngeal cancer, the surgeon must develop techniques to minimize postoperative

Figure 3



Identification of vascular pedicle before muscle cuts.

Figure 5



Postoperative complication. Group A: blue, group B: red, pharyngocutaneous fistula (PCF), wound gap (WG), carotid blowout (CB), flap failure (FF).

Table 2 Postoperative results

Variable	Group A (PMF)	Group B (primary repair only)
Pharyngocutaneous fistula (%)	1 (6.2)	12 (60)
Wound healing	Good	Poor
Oral feeding (mean) (days)	22.5	51.8
Hospital stay (median) (weeks)	3	10
Comorbidity (%)		
Wound gap	1 (6.2)	8 (40)
Carotid blowout	0 (0)	5 (25)
Flap failure	1 (6.2)	–

PMF, pectoralis major muscle flap.

complications in salvage laryngectomy surgery [3]. The effect of radiotherapy translates into injuries to tissue microvasculature, resulting in myointimal fibrosis, endarteritis and worsening of atherosclerosis, leading to a hypovascular, hypocellular and hypoxic environment, thus reducing healing capacity and increasing the risk for fistula formation, its severity and duration [3,5,6].

The use of nonirradiated flaps has been recommended to reduce the incidence rates and the morbidities associated with salivary fistulas in salvage laryngectomy patients, even when there is enough mucosa for a primary closure procedure [7,8]. The rationale of this strategy revolves around using healthy tissue with abundant vascularization to maximize surgical wound healing, thus preventing local complications. Nowadays, flaps have been used routinely in salvage laryngectomy procedures performed at head and neck surgery centers all over the world [9]. In this study we use the PMF in an effort to improve tissue vascularity, reinforce the pharyngeal suture line and minimize complications in this difficult patient group [6].

PCF is the most common major complication following laryngectomy. The severity of this fistula increases when it is preceded by chemoradiotherapy [10]. The use of PMF in salvage laryngeal surgery is of great help in high-risk patients to minimize incidence of PCF and to allow primary skin wound healing. This flap will give the patient the advantage of early oral feeding, good tracheostomy care, short hospital stay and protection against catastrophic vascular blowouts. The incidence rate of salivary fistulas in group A patients, who underwent augmentation of the pharynx by PMF, was 6.2%, which eventually healed. There were no carotid artery blowouts, and all patients had well-healed wound and resumed oral feeding. In contrast, group B showed 60% PCF rate, poor wound healing with gapping in 40% and carotid blowout in 25%. These results are in accordance with a meta-analysis study conducted by Paydarfar and Birkmeyer [5], which concluded that

preoperative radiotherapy increases the risk of PCFs ($P < 0.001$).

Our results are in accordance with those of a retrospective study conducted by Patel and Keni [9], who stated that there were no fistulas in patients for whom PMFs were used, compared with 57% for those in whom primary closure was performed. A study from Memorial University showed that rates of fistula occurrence were reduced from 22.9 to 1% when PMFs were used routinely in salvage laryngectomies [11]. In Weber study (without PMF flap), up to one-third of patients developed a PCF [12]. Oosthuizen *et al.* [10] recorded a PCF rate of 50% for salvage surgery patients without PMF reinforcement. The incidence rate of salivary fistulas in primary laryngeal closure, in a study by Alexandre *et al.* [13], was 32%, as also observed by other authors such as Varghese *et al.* [14] (41%), Van der Putten *et al.* [15] (30%) and Ganly *et al.* [16] (32%). Fistula was more common in patients who underwent initial primary closure (45%) than in patients who had immediate PMF only (10.5%) [17].

The mean duration to fistula closure was 22.5 days in group A compared with 51.8 days in group B. Oosthuizen *et al.* [10] showed that the mean time to fistula closure was 20.5 days in salvage patients with PMF compared with 57.16 days in those patients who developed a PCF following primary laryngectomy, indicating that the use of a PMF reduces the severity and duration of PCF in salvage surgery patients. Shorter hospital stay (average 3 weeks) was observed in group A compared with longer hospital stay (more than 9 weeks) in group B ($P < 0.001$). The same result was seen by Tsou *et al.* [18], who showed that the length of hospitalization of patients with PCFs was 37.6 days, compared with 20.7 days for patients without fistulas.

Our rate of total flap loss was 6.2% in this study compared with 2.4% in the study by Kroll *et al.* [19]; this is of great importance, as total flap necrosis is the only complication that requires another flap. One drawback of PMF is that follow-up in the neck region is more complicated because the flap can hide neck recurrences. The pectoralis major muscle pedicled flap is reliable and provides safe repair; the flap can be rapidly raised from the anterior chest wall, and no additional expertise in microvascular or abdominal surgery is needed. The main advantages reported are the ease of its technical aspects, the proximity of the head and neck region and the possibility of obtaining a large amount of well-vascularized tissue. As it is a regional flap, it does not require specific materials or teams specialized in microsurgical anastomoses, and it introduces low donor site morbidity [2,20,21]. The low morbidity to the donor site and execution in a

one-stage procedure has encouraged a wider use of PMF flaps. This flap could also reduce the risk of late complications such as stenosis, dysphagia and use of feeding tubes, as shown by Patel and Keni [9].

Conclusion

PCF and poor wound healing remain a significant problem following salvage laryngectomy. The use of nonirradiated, vascularized flaps [pectoralis major muscle pedicled flap (PMF)] reduces the incidence, duration and severity of fistula. It improves wound healing and should be considered if salvage laryngectomy is required.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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