

Prophylactic Chimera Anterolateral Thigh/Vastus Lateralis Flap: Preventing Complications in High-Risk Head and Neck Reconstruction

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Purpose: In high-risk head and neck cases treated with tumor resection and associated radical neck dissection, orocutaneous fistulas and wound breakdowns in the neck are relatively frequent and can have serious consequences, such as carotid blowout syndrome (CBS), the need for salvage reoperations, and prolonged recovery time. The authors present the application of a prophylactic chimeric anterolateral thigh (ALT) and vastus lateralis (VL) flap to prevent complications.

Materials and Methods: A retrospective review was performed of a historical group (96 patients) of patients with head and neck cancer treated with tumor resection, radical neck dissection, and microsurgical reconstruction of the tumor site only and a prospective cohort (21 patients) in which a chimeric ALT-VL flap was used to simultaneously reconstruct the tumor site and sternocleidomastoid muscle to fill dead space and protect the carotid artery.

Results: The rate of complications was higher in the historical group: CBS occurred in 4.1% and orocutaneous fistulas in 11.5% of patients; 5.2% of patients required major salvage surgery for a wound complication. In the cohort group, no CBS or orocutaneous fistula occurred and no major salvage surgical procedure was needed.

Conclusions: Prophylactic ALT-VL flaps in high-risk head and neck cancers provide adequate and long-lasting soft tissue coverage for the carotid artery, with minimal additional morbidity, and could be beneficial in preventing serious and life-threatening wound complications and the need for reoperation.

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In high-risk head and neck cases treated with tumor resection and associated radical neck dissection, orocutaneous fistulas and wound breakdowns in the neck are relatively frequent. The wound complication rate for advanced cancers requiring microsurgical reconstruction varies from 20 to 47% in irradiated patients.¹⁻³ In these cases, reoperation is often necessary to close the fistula and protect the neck vessels and is

responsible for longer hospitalization and a delay in adjuvant therapies. Wound complications also can lead to a devastating consequence, namely the carotid blowout syndrome (CBS), the threatened or acute rupture of the exposed carotid artery and its branches.

If deprived of the soft tissue coverage normally provided by the sternocleidomastoid muscle (SCM), when

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a wound breakdown occurs, the carotid artery is directly exposed and is subsequently at risk of rupture. This situation is facilitated by soft tissue necrosis in the neck and salivary fistulas, common complications after head and neck surgery.

CBS is classified into 3 types based on its clinical severity: acute, impending, and threatened⁴ (Table 1).

Impending and threatened CBS can be managed by using vascularized soft tissue coverage of the exposed carotid artery. The pectoralis major flap is the most frequently used flap for this purpose and is associated with intravascular stenting to repair the ruptured artery in impending cases.⁵⁻⁷

However, once the vessel wall has been damaged, long-term results of endovascular therapy are unfavorable for safety, stent patency, and hemorrhage prevention, and CBS has an average mortality rate of 40% and a morbidity of approximately 60%.⁸

The incidence of carotid rupture after radical neck dissection, with or without tumor resection, and multimodal therapy has been reported to be as high as 3 to 4%.⁹ Although the incidence might seem low, if the 40% mortality rate is taken into account, this problem is very relevant and deserves prevention.

Table 1. DESCRIPTION AND PROGNOSIS OF DIFFERENT TYPES OF CBS

Types of CBS	Description	Prognosis
Acute	profuse hemorrhage not controlled by surgical packing owing to carotid rupture	rapid evolution death occurs unless immediate resuscitation and closure of the artery are successfully performed
Impending	short episodes of sentinel hemorrhages that resolve spontaneously or with simple surgical packing	if left untreated, evolution into complete rupture
Threatened	exposure of the carotid artery because of wound breakdown or neoplastic invasion of the carotid artery	requires coverage with well-vascularized tissue to prevent rupture

Abbreviation: CBS, carotid blowout syndrome.

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Prophylactic flaps have become a standard procedure in high-risk operations for the prevention of vessel exposure or of major wound complications requiring reoperation in groin surgery and in salvage laryngectomy.¹⁰⁻¹⁴ The same principle, transferring a flap prophylactically to prevent complications, can find broader use in head and neck cancer surgery. Since 2009 the authors have used a chimeric flap in selected primary head and neck cancers requiring microsurgical reconstruction and radical neck dissection with sacrifice of the SCM, to prevent CBS, orocutaneous fistulas, and the need for salvage operations. Two soft tissue islands are included in the flap based on the same pedicle (descending branch of the lateral circumflex femoral artery): a skin island (anterolateral thigh [ALT] flap) to repair the primary tumor site and a muscle island (vastus lateralis [VL]) as a muscular prophylactic flap to replace the SCM and cover and protect the carotid artery.

This report describes and discusses the indications, surgical technique, and outcomes of the prevention of surgery-related complications with a chimeric ALT-VL flap.

Materials and Methods

PATIENT POPULATION

A retrospective review was performed of a prospective cohort and a historical group of patients with head and neck cancer treated at the same institution (Department of Surgical, Oncological, and Oral Sciences, University of Palermo, Palermo, Italy). The study was approved by the local institutional review board.

All patients in the 2 groups underwent radical resection of a primary cancer of the lower half of the head and neck area (oral cavity, mandibular region, cheeks, or auricular and parotid regions) and met the following eligibility criteria:

- Microsurgical reconstruction with soft tissue required for reconstruction of the tumor site
- Concomitant radical neck dissection with required sacrifice of the SCM
- Having received neoadjuvant radiotherapy (RT) or radiochemotherapy (RCT) or being a candidate for adjuvant RT or RCT

Of 800 patients with head and neck cancers treated from 2000 to 2008, 96 (12%) were selected according to these criteria and were treated with radical resection of the primary tumor, radical neck dissection with sacrifice of the SCM, and reconstruction of the tumor site with a free flap (58 radial forearm flaps, 36 ALT flaps, 1 VL flap, and 1 rectus abdominis flap).

From January 2009 to January 2012, 21 patients were selected from 187 head and neck cancer cases (11.1%). A chimeric ALT-VL muscle flap from the thigh was used to repair the primary tumor site and to simultaneously reconstruct the SCM (Fig 1). Twelve patients were men and 9 were women (mean age, 62 yr; range, 38 to 77 yr).

The tongue was the site most commonly involved (8 cases), followed by the cheek (4 cases), the retromolar trigone (4 cases), the floor of the mouth (3 cases), the mastoid area (1 case), and the auriculo-parotid region (1 case).

Three patients had preoperative neoadjuvant chemoradiation (Table 2, patients 1, 14, and 18). One patient had postoperative radiation only (Table 2, patient 13). All other patients had adjuvant chemoradiation after surgery. Data from these patients are presented in Table 2.

The 2 groups showed a similar distribution in age, gender, tumor stage, comorbidities, and smoking and were compared for the rate of wound breakdown, orocutaneous fistulas and CBS, need for salvage operations, and hospital stay.

SURGICAL TECHNIQUE

Flap planning does not differ substantially from planning a conventional ALT flap.

The flap inset is of no particular challenge when a transmandibular approach is used or the defect is located in the skin. The ALT flap should be inset before vascular anastomoses and sutured to the defect; then, the pedicle is passed into the neck under direct vision.

When primary cancer surgery has been performed through an intraoral approach with a pull-through technique, a wide tunnel, depending on the skin flap size, will have to be made and the flap delivered from the neck to the mouth. Any excess tension on the perforator must be avoided in these cases. After the skin flap is sutured to the defect, the muscle is temporarily wrapped in moist gauze and transferred to cover the vessels once the anastomoses have been completed. Its cut ends are sutured to the aponeurotic stumps of the SCM (Fig 2). The skin island of the flap is used for monitoring. Nerve coaptation is not necessary for coverage. The muscle is not meant to restore function, but to provide prophylactic coverage to the vessels. Muscle atrophy from denervation will not cause loss of coverage, but rather, only fibrous and adipose degeneration, as discussed later in the article.

Results

The complication data of the 2 groups are presented in Table 3. In the historical group (2000 to 2008), 28 patients (29.2%) developed a wound complication and 5 patients (5.2%) required major salvage surgery.

Wound dehiscence occurred in 17 patients (17.7%), 13 (13.5%) of whom were treated conservatively or with a minor surgical procedure for secondary wound closure, whereas 4 patients (4.2%) developed a CBS. There were 2 cases (2.1%) of threatened CBS, one of which occurred during postoperative RT; these cases required a pectoralis major flap to protect the exposed carotid artery. The other 2 patients developed acute CBS and died of this complication. An orocutaneous fistula occurred in 11 patients (11.5%), one of which required a salvage pectoralis major flap. Other complications were infection (2%), hematoma (1%), partial flap necrosis (1%), and total flap loss (1%). The mean hospital stay was 17 days (range, 10 to 45 days).

In the prospective cohort (2009 to 2012), the wound complication rate was 14.3% (3 patients), and no major salvage surgery was needed to cover exposed neck vessels or to repair an orocutaneous fistula. There were 3 (14%) postoperative wound dehiscences that were managed with local wound care or secondary closure. No orocutaneous fistula or CBS occurred.

Despite early pharmacologic thrombolysis,¹⁵ partial flap necrosis was observed in 1 case (4.8%). The cutaneous ALT flap of the chimeric flap in the oral cavity died owing to perforator compression or stretching within the tunnel connecting the neck to the oral cavity. A salvage radial forearm flap was performed 5 days after the initial procedure and healed uneventfully.

No complete flap necrosis or other complication was observed. One tracheocutaneous fistula occurred and was treated with a local flap. The remaining 17 patients healed uneventfully within 1 month after the operation with a single major surgical procedure.

The VL flap provided adequate and long-lasting soft tissue coverage for the carotid artery as shown by postoperative CT scans (Fig 3). Two years after the operation, stable coverage was still present, with the muscle maintaining an average thickness of 2.23 cm (range, 1.7 to 2.8 cm). Four patients died of metastatic disease and 1 of heart failure. After a mean follow-up of 32 months (range, 18 to 32 months), the remaining 16 patients were alive and free from disease. The mean hospital stay was 13 days (range, 10 to 32 days).

Discussion

Local complications, such as wound breakdown, orocutaneous fistulas, infection, and delayed healing, are relatively frequent in these cases owing to the contaminated intraoral environment, saliva permeation, comorbidities, and poor nutritional status of these patients. In advanced-stage head and neck cancers, adjuvant and neoadjuvant radiation with or without chemotherapy compromise tissue vascularity and increase the risk of wound complications. Furthermore, such complications require a salvage operation

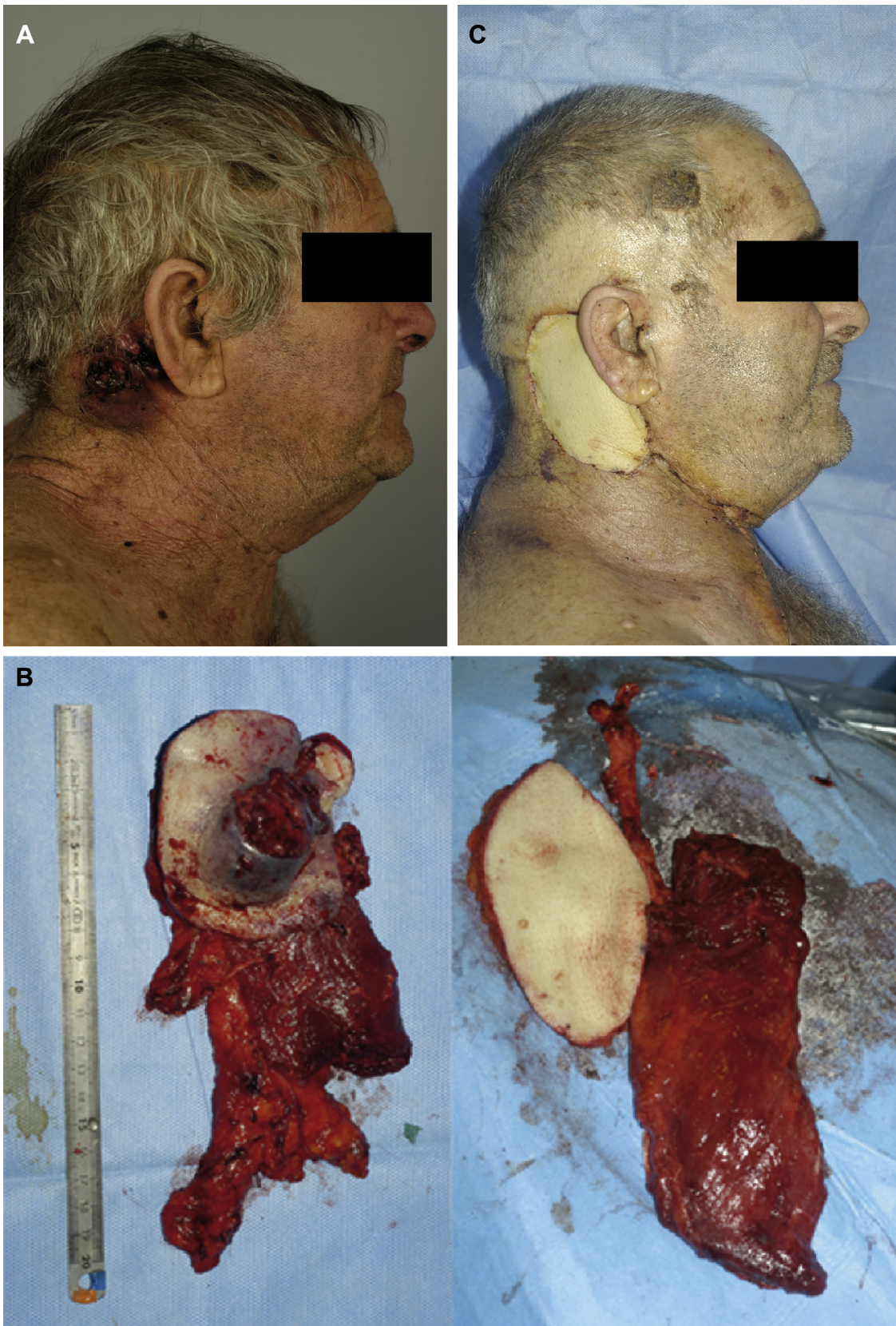


FIGURE 1. Case 7. A, Preoperative photograph displays a retroauricular squamous cell carcinoma with direct invasion of the sternocleidomastoid muscle. B, Photographs show the resected specimen (*left*) and the flap used for reconstruction (*right*). This is a clear example of how anatomic such a reconstruction can be by closely reproducing the features of the resected tissues. C, Postoperative result 1 month after operation.

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Table 2. PROSPECTIVE COHORT (2009 TO 2012)

Patient Number	Gender/ Age	Cancer/Location	Surgical Approach	Neoadjuvant/ Adjuvant Treatment	Complications
1	M/42	SCC G2/retromolar trigone	lateral emivisor approach wide resection and RND ALT-VL free chimeric flap	pre-op CRT	neck skin necrosis with exposure of muscular component of chimera flap
2	M/77	SCC G2/tongue	C.TM approach emiglossectomy and RND ALT-VL free chimeric flap	post-op CRT	tracheocutaneous fistula secondary surgery: local flap
3	M/76	SCC G3/tongue	C.TM access subtotal glossectomy and RND ALT-VL free chimeric flap	post-op CRT	superficial neck skin necrosis
4	F/75	SCC G2/tongue	transoral approach emiglossectomy and RND ALT-VL free chimeric flap	post-op CRT	none
5	M/59	SCC G2/tongue and floor of mouth	C.TM approach emiglossectomy, partial pelvectomy, RND ALT-VL free chimeric flap	post-op CRT	none
6	M/45	SCC G2/cheek	transoral approach wide excision and RND ALT-VL free chimeric flap	post-op CRT	superficial neck skin necrosis
7	M/71	SCC G3/mastoid region	wide excision and RND ALT-VL free chimeric flap	post-op CRT	none
8	F/75	SCC G1/retromolar trigone	C.TM approach wide excision and RND ALT-VL free chimeric flap	post-op CRT	none
9	F/60	SCC G2/tongue	transoral approach emiglossectomy and RND ALT-VL free chimeric flap	post-op CRT	partial necrosis of ALT flap secondary surgery: forearm flap
10	F/58	SCC G2/cheek	transoral approach wide excision and RND ALT-VL free chimeric flap	post-op CRT	none
11	M/73	SCC G3/tongue and floor of mouth	C.TM approach emiglossectomy, partial pelvectomy, RND ALT-VL free chimeric flap	post-op CRT	infection conservative treatment
12	F/65	SCC G3/tongue	C.TM approach emiglossectomy and RND ALT-VL free chimeric flap	post-op CRT	none
13	F/66	SCC G3/cheek	transoral approach wide excision and RND ALT-VL free chimeric flap	post-op RT	none
14	M/70	SCC G3/tongue and floor of mouth	C.TM approach wide excision and RND ALT-VL free chimeric flap	pre-op CRT	none
15	F/38	SCC G3/tongue, retromolar trigone, tonsil	emivisor lateral approach wide excision and RND ALT-VL free chimeric flap	post-op CRT	none
16	M/65	SCC G2/floor of mouth and alveolar ridge	transoral approach wide excision and RND ALT-VL free chimeric flap	post-op CRT	none
17	M/39	SCC G3/auricular-parotid region	wide excision and RND ALT-VL free chimeric flap	post-op CRT	none

Table 2. Cont'd

Patient Number	Gender/ Age	Cancer/Location	Surgical Approach	Neoadjuvant/ Adjuvant Treatment	Complications
18	M/71	SCC G3/tongue and retromolar trigone	C.TM approach wide excision and RND ALT-VL free chimeric flap	pre-op CRT	none
19	F/72	SCC G2/cheek and alveolar ridge	transoral approach wide excision and RND ALT-VL free chimeric flap	post-op CRT	none
20	M/68	SCC G3/floor of mouth	composite transmandibular resection and RND ALT-VL free chimeric flap	post-op CRT	none
21	F/63	SCC/floor of mouth	C.TM approach wide resection and RND ALT-VL free chimeric flap	post-op CRT	none

Abbreviations: ALT, anterolateral thigh; C.TM, conservative transmandibular; CRT, chemoradiation; F, female; M, male; post-op, postoperative; pre-op, preoperative; RND, radical neck dissection; RT, radiotherapy; SCC, squamous cell carcinoma; VL, vastus lateralis.

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with the associated morbidity,^{5,6} prolonged hospital stay, longer time to recovery, and subsequent delay in adjuvant treatments, which can be very detrimental to patients with advanced disease. The likelihood of a wound complication requiring reoperation in high-risk cases exceeds 20%^{3,5,6,8,12-14} and justifies the adoption of prophylactic measures to avoid it.

Prophylactic flaps have become a common procedure in high-risk cases in vascular surgery and head and neck surgery. Muscle flaps represent a standard procedure in groin surgery after node dissections or after vascular surgery to prevent vascular exposure.^{10,11} In head and neck surgery, prophylactic transfer of a pedicled or free flap is used to prevent wound complications and vessel exposure after total laryngectomy.¹²⁻¹⁴ In these settings, prophylactic flaps decrease postoperative complications rates, hospital stay, need for reoperation, and need for antibiotics and speed up patients' recovery.¹⁰⁻¹⁴

High-risk head and neck cancers requiring microsurgical reconstruction have exactly the same problems. The reported incidences of wound complications vary from 20 to 47% in irradiated patients and reoperations are necessary in up to 22% of cases.¹⁻³

Prophylactic coverage of the carotid artery is also effective in minimizing a relatively infrequent but life-threatening complication, namely CBS, which is more frequent in the threatened form and reported to be as frequent as 4%.^{4,8} In these cases, when facing a wound breakdown in the cervical area, if the carotid is protected by well-vascularized muscle, conservative treatment or minor procedures can allow wound closure without major salvage operations.

The authors believe that these figures justify the introduction of prophylactic measures to decrease the incidence of complications and reoperations in high-risk cases. The use of prophylactic muscle flaps in this setting has been reported by other investigators.^{7,12-14}

In the present series, the rate of wound breakdown requiring only conservative treatment and minor revision surgery was similar in the historical and prospective groups (13.5% and 14.4%, respectively). However, an additional 4.1% of patients with a wound breakdown developed a CBS in the historical group, with a related mortality of 50%, whereas the carotid artery was well protected in the cohort treated with a prophylactic chimeric ALT-VL flap and no CBS occurred (Fig 4). The difference in the rate of orocutaneous fistulas was even greater (11.5% vs 0%).

No major salvage procedure after a wound complication was needed in the prospective cohort, whereas it was necessary in 5.2% of patients in the historical group. The mean hospital stay was slightly longer in the historical group (17 vs 13 days), owing to the longer hospitalization required in case a major reoperation was performed (mean, 30 days; range, 20 to 45 days), which led to a delay in adjuvant treatments. Although a statistical analysis was not performed owing to the small samples, the difference rates between the 2 groups suggest that the prophylactic muscle flap was effective in preventing those complications.

The pectoralis major flap represents the first choice of flap for the treatment of threatened CBS and orocutaneous fistulas, but its use as a prophylactic muscle flap was reported by Schneider et al⁷ to fill dead space

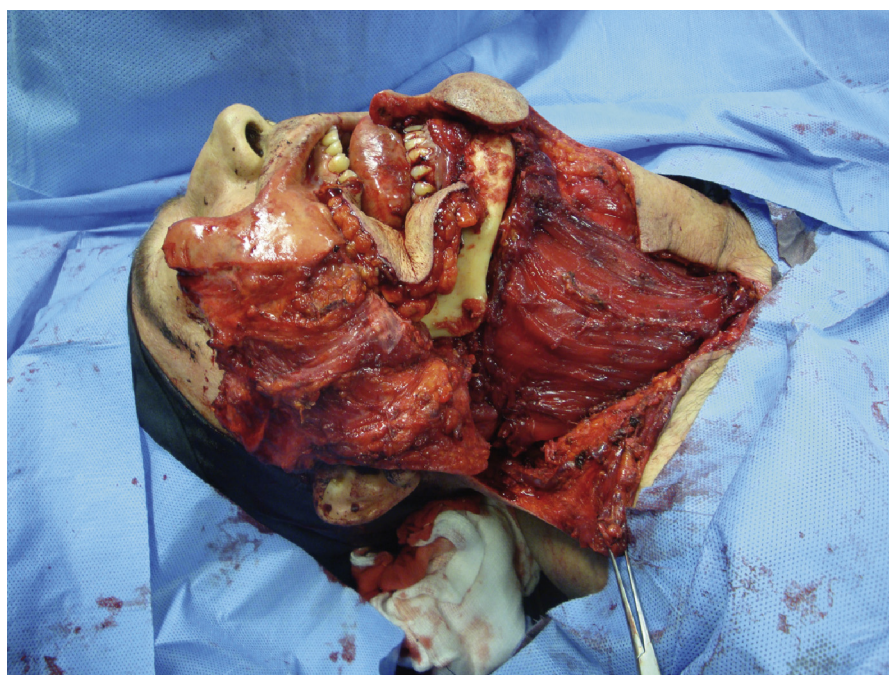


FIGURE 2. Case 1. Intraoperative view of 42-year-old patient who had undergone chemoradiation before the operation for a squamous cell carcinoma. Resection involved the retromolar trigone, part of the tongue, and the hard and soft palate en bloc with radical neck dissection, marginal mandibulectomy, and partial maxillectomy. Photograph shows the flap after completion of the anastomosis and partial inset. The anterolateral thigh has been tunneled to the mouth and the vastus lateralis has been used to completely cover the carotid as the sternocleidomastoid muscle did.

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and protect the carotid artery after radical neck dissection combined with a concurrent free tissue transfer.

The chimeric ALT-VL flap has the advantages of not requiring a second flap or a new donor site and of avoiding the significant morbidity correlated with pectoralis

major flap harvest. Only a minimal modification of the microsurgical reconstructive planning is needed, which allows for filling of dead space and protection of the carotid artery. The ALT flap has become a standard flap for head and neck surgery and can be a valid

Table 3. COMPLICATION RATE, SECONDARY SURGERY, AND TREATMENT-RELATED MORTALITY IN THE HISTORICAL (2000 TO 2008) AND PROSPECTIVE (2009 TO 2012) GROUPS

Complications	Complication Rate		Major Salvage Procedures		Minor Reoperations		Treatment-Related Mortality	
	2000-2008 Series, n (%)	2009-2012 Series, n (%)	2000-2008 Series, n (%)	2009-2012 Series, n (%)	2000-2008 Series, n (%)	2009-2012 Series, n (%)	2000-2008 Series, n (%)	2009-2012 Series, n (%)
Overall wound complications	28 (29.2)	3 (14.3)	5 (5.2)	0 (0)	5 (5.2)	1 (4.8)	2 (2.1)	0 (0)
Wound breakdown (no CBS)	13 (13.5)	3 (14.3)	0 (0)	0 (0)	5 (5.2)	1 (4.8)	0 (0)	0 (0)
Wound breakdown (CBS)	4 (4.2)	0 (0)	2 (2.1)	0 (0)	0 (0)	0 (0)	2 (2.1)	0 (0)
Orocutaneous fistula	11 (11.5)	0 (0)	3 (3.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other complications (infection, hematoma, flap necrosis)	6 (6.3)	2 (9.5)	3 (3.1)	1 (4.8)	1 (1)	1 (4.8)	0 (0)	0 (0)

Abbreviation: CBS, carotid blowout syndrome.

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FIGURE 3. Computed tomogram obtained 2 years after operation. Although the patient has undergone radiotherapy and 2 years of denervation have caused muscle atrophy, an adequately thick tissue layer still protects the carotid artery.

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alternative to the radial forearm flap, and chimeric flaps from the lateral circumflex femoral system have many applications in head and neck surgery,¹⁶⁻¹⁹ even for the prevention of orocutaneous fistulas.²⁰

Transfer of a chimeric flap, including a portion of the VL muscle, adds some time (0.5 hour on average) to the operation, carries little additional risk because the 2 flaps are supplied by a single pedicle (no additional anastomoses), and causes little additional morbidity to the thigh. Harvesting of the VL muscle has been associated with minimal donor-site morbidity, similar to that resulting after ALT flap transfer.^{21,22}

The study has some limitations. A statistical analysis was not possible because of the small size and different sample of the historical and prospective groups. Differences in radiation oncology techniques in the 2 groups

were not evaluated and could have influenced the complication rate: newer RT techniques (such as intensity-modulated RT) are likely to carry a lower additional risk of CBS compared with older techniques; in addition, differences in timing (adjuvant vs neoadjuvant) could play a role in decreasing wound complications. However, only a minority of head and neck cancers requires radical neck dissection, including the SCM, and only a small number will develop a CBS. These characteristics of the population make it difficult to prospectively evaluate the potential of prophylactic flaps and to obtain large series for statistical validation. No prospective study is available in the literature, although prophylactic reconstruction with an additional flap has been reported⁷ and is a currently discussed practice for the prevention of life-threatening

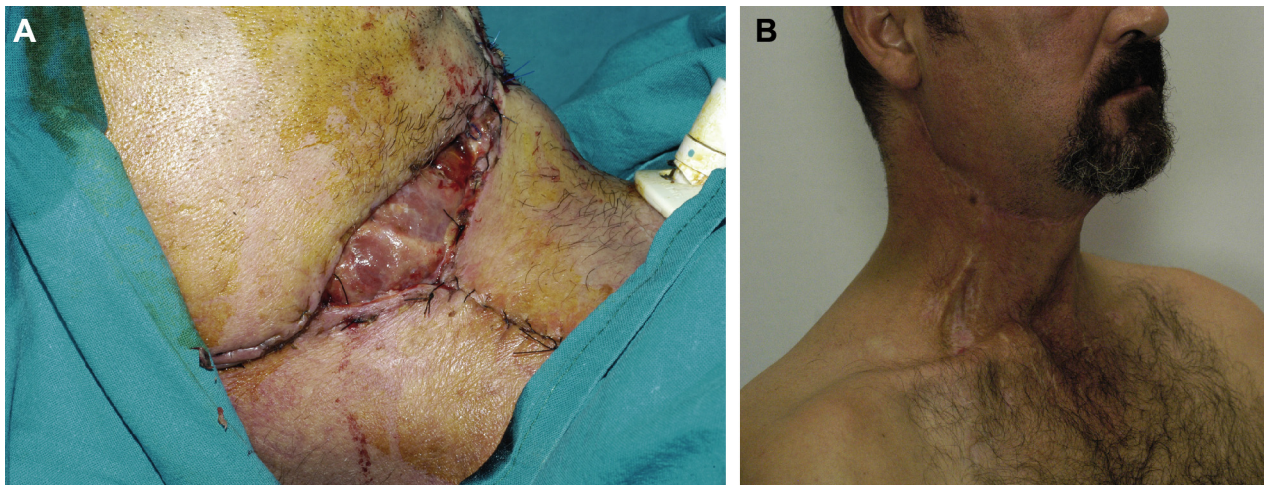


FIGURE 4. A, Wound breakdown 1 month after operation. Without appropriate coverage of the carotid, this situation would have resulted in a threatened blowout syndrome. The vastus lateralis muscle is visible through the wound, protects the carotid artery, and provides a well-vascularized bed that allows the wound to heal spontaneously. B, One-year postoperative view shows how the wound has healed without further intervention.

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complications. Although the present study does not allow for statistical conclusions, the difference in the occurrence rate of orocutaneous fistulas and CBS between the 2 groups (11.5% and 4.1%, respectively) suggests a protective role of the technique, whose morbidity is significantly lower than that of the combination of a free flap with a pectoralis major flap.

A larger radial forearm or ALT flap could be partly de-epithelialized using the de-epithelialized soft tissue portion for carotid artery protection. However, this approach significantly restricts freedom in the flap inset, cannot be used for all defect locations, and does not allow for a “like-with-like” reconstruction. When used for intraoral reconstruction, the connection to the cervical portion of the flap will restrict movement of the intraoral part by adding weight and bonding the flap to the neck, and the continuity between the 2 portions of the flap could facilitate the formation of orocutaneous fistulas.

Some other criticisms may be made. The 3-dimensional inset of the flap is somewhat more complicated than in a conventional flap when a transoral approach is used, because of the need for skin flap tunneling from the neck to the mouth. It might be argued that a denervated muscle atrophies and thus cannot provide long-lasting coverage. However, atrophy is not disappearance, but rather, fibrofatty degeneration owing to loss of the neuromuscular junctions and of the muscular architecture and subsequent replacement with fibrous and fatty tissue, as depicted by postoperative CT scans.

The ALT-VL chimeric flap is a valid option for simultaneous repair of the primary tumor site and replacement of the SCM in selected patients affected by

advanced head and neck cancer of the lower half of the head and neck area who satisfy the following criteria of inclusion:

- Microsurgical reconstruction of the primary cancer with soft tissue required, ie, flaps
- Radical neck dissection with sacrifice of the SCM
- Neoadjuvant or adjuvant RT or RCT

In this selected high-risk population, reconstruction with a prophylactic chimeric ALT-VL flap provides adequate and long-lasting soft tissue coverage for the carotid artery with minimal additional morbidity and could be beneficial in decreasing the need for reoperations, speeding up recovery, decreasing time to adjuvant therapies, and minimizing the risk of life-threatening complications such as CBS. The authors believe this prophylactic approach deserves to become part of the reconstructive algorithm of advanced-stage cancers of the lower half of the head and neck area.

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