

perforator, effective tongue mobility preservation allowing for its extrusion beyond the incisors line, sufficient bulk to restore the volume of the neotongue and to obliterate dead space from tumor ablation, reduced risk of hardware exposure and possibility of osteoradionecrosis, adequate bony scaffold to enhance oral rehabilitation and optional endosseous implant placement, and single couple of recipient vessels for microvascular anastomoses.

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The Pectoralis Major Myocutaneous Pedicled Flap: A Refined Surgical Technique

Antonio Romano, MD,* Carolina Sbordone, MD,*
Giorgio Iaconetta, MD,† Marco Friscia, MD,*
Luigi Califano, MD*

Abstract: The pectoralis major myocutaneous pedicled flap is a commonly used flap for reconstructive head and neck surgery, but

associated with high complication rates. The purpose of this study was to evaluate a refined surgical technique that can reduce flap complications and compare the proposed technique with the conventional surgical technique. A retrospective analysis was performed on 35 consecutive patients affected by malignant tumors of the head and neck, who underwent a pectoralis major myocutaneous pedicled flap reconstruction in our institution, between 2004 and 2009. Patients were divided into 2 groups: group 1 treated by the classic surgical technique, and group 2 treated by the refined surgical technique. Our main outcome measures were the success of the reconstructions and the complications. The overall complication rate in patients who underwent our revisited surgical technique was significantly lower than that in patients who underwent conventional surgical technique ($P = 0.001$). The results of our study reinforce the value of the pectoralis major flap in the reconstruction of head and neck defects and shows how little refinement of the surgical technique can significantly reduce the onset of complications.

Key Words: Reconstructive head and neck surgery, pectoralis major muscle, postoperative complications

The pectoralis major myocutaneous pedicled (PMMC) flap is a commonly used flap for reconstructive head and neck surgery. It has been applied to the reconstruction of a variety of chest wall defects since 1947 when Pickerel et al¹ reported its use as a turn-over flap. Ariyan^{2,3} has been the first to use this pedicle flap for head and neck defects. Nowadays, free flaps are more common because of improved microsurgical techniques, but in several cases the PMMC flap still has its advantages, including its proximity to the head and neck, the simplicity of harvesting, the short surgical time, and its use as an alternative when microsurgical flap failure occurs.⁴ The disadvantages can include a reduced neck mobility and the need to rotate 180 degrees the vascular pedicle of the flap when using the skin paddle to resurface the neck. Another disadvantage, which can lead to possible reduced swallowing or speech function, can be the excessive thickness of the flap, which is determined by the amount of subcutaneous fat between the pectoralis muscle and the overlying skin paddle.⁴ Because of high complication rates reported in literature, the aims of the current study were to evaluate a refined harvesting surgical technique that can reduce flap necrosis complication and to compare the conventional surgical technique with the proposed refined surgical technique.

MATERIALS AND METHODS

A retrospective analysis was performed on 35 consecutive patients, who underwent a PMMC flap reconstruction in our institution, between 2004 and 2009. Patients eligible for the analysis were those

From the *Department of Maxillo-Facial Surgery, School of Medicine, University of Naples “Federico II”, Naples; and †School of Medicine, University of Salerno, Italy.

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Address correspondence and reprint requests to Carolina Sbordone, MD, Department of Maxillo-Facial Surgery, School of Medicine, University of Naples “Federico II,” Via Pansini n.5 80100 Naples, Italy; E-mail: carolina.84@hotmail.it

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TABLE 1. Complications Associated With Pectoralis Major Myocutaneous Flap

Major Complications	Minor Complications
Total necrosis	Partial necrosis
Fistula	Infections
	Dehiscence
	Hematoma
	Supraclavicular bulge
	Female breast distortion
	Donor-site complication

with malignant tumors of the head and neck who underwent an immediate reconstruction with use of the pectoralis major myocutaneous flap and in which the skin paddle of the PMMC flap was placed over the pectoralis major muscle and did not extend over the rectus abdominis muscle. Among these 35 patients, only 27 satisfied our surgical criteria. Records of all patients were reviewed (Table 2). For each patient, the following data were recorded: sex, age, medical history, American Joint Committee on Cancer staging 10, outcome, and total time of follow-up. The 27 patients were divided into 2 groups: group 1, 13 patients, underwent the classic surgical technique; group 2, 14 patients, underwent the refined surgical technique. Our main outcome measures were the success of the reconstructions and the complications. The results were compiled and reported as complication versus no complication, and multiple subgroup analyses were done in attempts to identify risk factors for complications and/or failures. Statistical analysis was done using a 2 × 2 table approach to evaluate proportions, comparing one variable with the other to determine which was more important as a predictor of complications. The Fisher exact test was used to determine statistical significance.

Flap complications were classified as major and minor, as Zbar et al⁵ described (Table 1). Major flap complication was defined as tissue loss or wound-healing problems that required an additional operative intervention to obtain wound closure and accomplish the reconstructive goal. Major flap complications were considered outcome failures because the PMMC flap failed to accomplish the established preoperative goal. Minor flap complications included tissue loss or wound dehiscence, which could

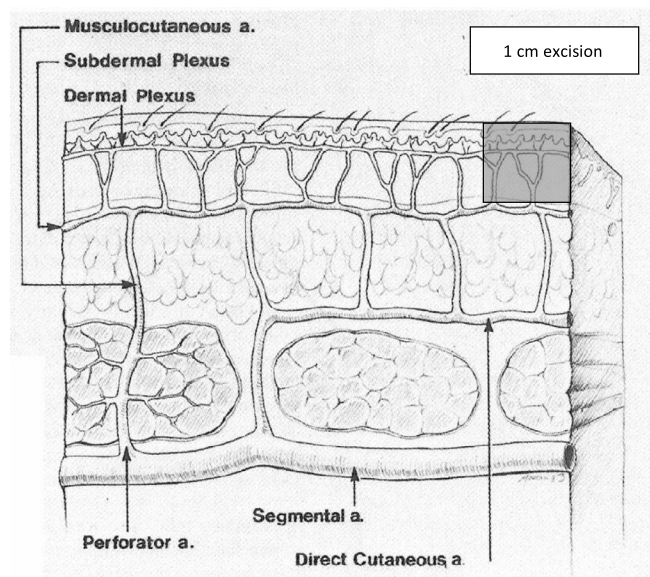


FIGURE 1. Scheme of the skin incision of the refined surgical technique.



FIGURE 2. Step 1 of the refined surgical technique: the skin paddle is marked over the caudal-medial portion of the pectoralis major muscle not extending over the rectus abdominis muscle; the vascular axis is drawn on the skin of the chest. A first circumferential incision around the skin paddle is made, and a second skin incision 1 cm at the periphery of the first one is completed.

be managed with conservative wound care, including bedside debridement and antibiotics.⁵

Surgical Technique

Key Points of the Conventional Surgical Technique Used for Harvesting the Pectoralis Major Flap (ST1)

Initial skin incision was along the previously marked pectoral skin island deep through subcutaneous fat to the pectoral fascia in the marked area. The skin island was tightened to the muscle with continuing absorbable sutures to protect the skin island during operative handling and postoperative healing. The next skin incision was designed as a lower limb of a deltopectoral flap, from the lateral edge of the pectoralis skin island to the anterior axillary fold.⁶ The prepectoral skin was elevated in the plane above the pectoral fascia. As the lateral border of the pectoralis major was identified, blunt dissection was performed to separate major and minor pectoral muscle, and the neurovascular pedicle (pectoral branch of the thoracoacromial artery) was identified. After dissecting the flap off the chest wall, a subcutaneous tunnel was formed under the skin between neck and chest, and the flap passed underneath the skin bridge. The flap was placed into the defect and sutured in 2 layers. The donor defect was closed primarily.⁷

Key Points of the Refined Surgical Technique Used for Harvesting the Pectoralis Major Flap (ST2)

A skin paddle was marked over the caudal-medial portion of the chest wall, placed over the lower portion of the pectoralis major



FIGURE 3. Step 2 of the refined surgical technique: initial skin incision is along the previously marked pectoral skin island only through epidermis, and a de-epithelialization of the epidermal layer for 1 cm at the periphery of this incision is made.



FIGURE 4. Step 3 of the refined surgical technique: a 1-cm strip of dermis is left around the skin paddle, so the pectoralis major is elevated off the chest wall by blunt and sharp dissection through subcutaneous fat to the deep pectoral fascia.

muscle, not extending over the rectus abdominis muscle; the vascular axis was drawn on the skin of the chest.

A circumferential incision along the previously marked pectoral skin island was made, only through epidermis. Then a de-epithelialization of the epidermal layer, 1 cm at the periphery of this incision, was performed, to leave a 1-cm strip of dermis. The skin island was tightened to the muscle with silk sutures to protect the skin island during operative handling and postoperative healing. As the lateral border of the pectoralis major was identified, blunt dissection was performed to separate major and minor pectoral muscle, and the neurovascular pedicle (pectoral branch of the thoracoacromial artery) was identified. The medial attachments of the muscle to the sternum were then transected up to the level of the clavicle. A strip of muscle was left in site to protect the vascular pedicle in the rotation in the neck. After dissecting the flap off the chest wall, a subcutaneous tunnel was formed under the skin between neck and chest, and the flap was passed underneath the skin bridge. The flap was placed into the defect and sutured in 2 layers. The donor defect was closed primarily (Figs. 1–4).

RESULTS

The medical charts of 27 patients were reviewed. All patients underwent PMMC flap, and all PMMC flaps were used as part of an oncologic reconstruction. Most of the 27 patients were male (n = 23), with a median age of 65 years. The location of the tumors varied from the oral cavity (n = 5) and tongue (n = 22), and the staging ranged from T2 (n = 7) and T3/T4 (n = 19) (Table 2). The PMMC flap reconstruction was used for various indications in our study; the most common was soft tissue fill after recurrence of a squamous cell carcinoma or untreated squamous cell carcinoma, threatened coverage, prophylactic cov-

TABLE 2. Clinical Data for the 27 PMMC Flap Participants

Age, y	30–85 (Median, 68)
Sex	Male n = 23 Female n = 4
Surgical technique	Conventional technique (ST1) n = 13 Refined technique (ST2) n = 14
TNM	T2 n = 7 T3/4 n = 20
Total complications for	Conventional technique (ST1) n = 11 Refined technique (ST2) n = 3

TABLE 3. Summary of Reconstruction Sites

Reconstruction Site	No. Patients (Total = 27)
Total glossectomy	16
Partial glossectomy	6
Oral cavity	5

TABLE 4. Summary of Reconstruction Sites Associated With the Used Surgical Technique

Reconstruction Site	Conventional Surgical Technique (ST1)	Refined Surgical Technique (ST2)
Total glossectomy	7	9
Partial glossectomy	4	2
Oral cavity	2	3
Total patients	13	14

erage, and primary protection of vascular structures. Of these 27 patients, 16 underwent total glossectomy, 6 partial glossectomy, and 5 underwent a resection of part of the oral cavity (Table 3). The flaps were used to reconstruct mucosal defects in all 27 patients, and in 2 patients, a metal plate to reconstruct the mandible was used. The follow-up period ranged from 3 months to 5 years. In 14 patients, our proposed surgical technique for harvesting the pectoral flap was performed, and in the other 13 patients, the classic harvesting technique was performed (Table 4). Evaluation of the effectiveness of the surgical technique was obtained on the overall rate complications. Only flap-related complications were analyzed. The overall complication rate in patients who underwent our revisited surgical technique of pectoralis major flap was 21%, whereas overall complication rate in patients who underwent the classic surgical technique for pectoralis major flaps was 85%, including 2 cases with total necrosis. Other complications included partial necrosis, infection, salivary fistula, and dehiscence. The flap-related complications were compared with regard to patient age (<70 vs >70 years), tumor staging, site of reconstruction, and type of resection, and no statistically significant differences were observed (Table 5). The overall complication rate in patients who underwent our revisited surgical technique was significantly

TABLE 5. Analysis of Risk Factors Associated With Flap Complications (Fisher Exact Test Both Tails for P = 0.05)

Risk Factors	ST1	ST2	P
Age			
<70 y complication	3/4	1/3	1
≥70 y complication	8/9	2/11	
T classification			
T2	3/4	1/3	1
T3/4	8/9	2/11	
Site			
Tongue	10/11	2/11	0.39
Oral cavity	1/2	1/3	
Type of resection			
Partial gloss	4/4	0/2	0.51
Total gloss	6/7	2/9	

TABLE 6. Complication Rate Comparison Between Pectoralis Flap Harvested With Conventional Surgical Technique (ST1) and Refined Surgical Technique (ST2) (Fisher Exact Test Both Tails for $P = 0.05$)

	ST1	ST2	P
Without complication	2	11	0.001
With complication	11	3	

lower than that in patients who underwent conventional surgical technique ($P = 0.001$) (Table 6).

DISCUSSION

The pectoralis major muscle is a fan-shaped muscle that covers much of the anterior thoracic wall. The action of this muscle is to rotate medially and to abduct the arm. According to the classification scheme of Mathes and Nahai,⁸ the pectoralis major is a V-type muscle, with 1 major vascular pedicle from the thoracoacromial artery and secondary segmental parasternal perforators that arise medially from the internal mammary artery. The thoracoacromial artery is a branch from the second part of the axillary artery; it commonly divides into 4 main branches: deltoid, acromial, clavicular, and pectoral. It is the latter branch that supplies the pectoralis major.

Ariyan's^{2,3} original description of PMMF incorporated a long segment of skin that extended from the clavicle to the caudal extent of the muscle. It is recognized that a distal skin paddle placed over the caudal extent of the pectoralis muscle is well vascularized and permits a greater arc rotation.

The conventional harvesting technique describes that part of the muscle is left by the vascular pedicle to protect it, determining a limit in the arc of rotation and giving an excessive thickness to the flap. To reduce the bulk of the skin and subcutaneous tissue, Sharzer et al⁹ described harvesting a vertically oriented parasternal skin paddle that extended across the sternum to the opposite internal mammary perforators. The skin paddle overlying the sternum achieved a considerable reduction of bulk. Magee et al¹⁰ described the placement of the skin paddle over the lower portion of the pectoralis major with an extension overlying the rectus abdominis muscle. Wei et al¹¹ described an alternative solution by harvesting a skin paddle over the sternocostal portion of the muscle. The blood supply to that portion of the muscle was isolated from the vascular supply to the clavicular portion of the muscle. Good results are reported for PMMF,¹² but high complication rates are also mentioned,^{13,14} and they seem to be higher than in free flap reconstruction.¹⁵ No higher complication rate seems to be related to the presence of more than 1 risk factor (heavy smokers, preoperative radiotherapy, diabetes, or obesity).¹⁶

The pectoralis major musculocutaneous flap is versatile in the reconstruction of large defects of the head and neck, and it can easily be used in a 1-stage operative procedure. The mean operative time of the pectoralis major musculocutaneous flaps was markedly shorter than that of the free flaps, which may result from the omission of microanastomosis inherent in free flaps.¹² In a patient with multiple preoperative morbidities, a long surgical time may cause considerable damage, and a reconstruction with PMMF may be considered first. The PMMF has a low incidence of complete flap failure; total flap necrosis is reported to be 3%,¹⁵ whereas partial flap necrosis has been reported at a much greater rate (29%). Other complications can be partial or total skin necrosis, orocutaneous fistulae, dehiscence, supraclavicular bulge, female breast distortion, and donor-site complications such as hematoma or seroma, excessive wound

tension, necrosis of the skin of chest wall, and restrictive pulmonary disease.¹⁷ Partial necrosis of the flap is common, and excessive bulk may be problematic. In wounds that pose healing problems as a result of poor nutrition or prior radiation, the effect of gravity can be extremely detrimental and require an alternative flap. Orocutaneous fistulae are common and serious complications, related to poor perfusion of the skin paddle and related partial necrosis. One of the common causes of these problems is the placement of the skin paddle too low on the chest wall. In this study, the skin paddle was always designed over the lower portion of the pectoralis major muscle, not extending over the rectus abdominis muscle, medial to the nipple. Furthermore, the technique of pectoralis major musculocutaneous flap elevation was refined to increase mobility and guarantee safety. This variation of the technique used to set the pectoral skin island reduces the percentage of complications such as partial flap necrosis, orocutaneous fistulae, and dehiscence. The suture of the 1-cm dermal-hypodermal layer to the oral cavity tissues leaves a good distance from the epidermal layer so that the necrosis of this dermal strip can limit and restrain the necrosis of the epidermal layer. The surgical technique proposed can so reduce the development of orocutaneous fistulae and dehiscence of surgical wound. The results of our studies reinforce the value of the pectoralis major flap in the reconstruction of head and neck defects and show how little refinement of the surgical technique can significantly ($P = 0.001$) reduce the onset of complications. In some patients, the pectoralis major flap represents a good alternative to the free flap and can present less risk and acceptable results for the patients.

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FIGURE 1. Photograph of the patient with left preauricular pulsatile hemorrhagic wound due to pseudoaneurysm of the STA. The hemorrhage was controlled with compressing dressing.

Pseudoaneurysm of the Superficial Temporal Artery Following Penetrating Trauma

Fereydoun Pourdanesh, DMD, MS,*
 Mohammadtaghi Salehian, MD, FIAS,†
 Pooneh Dehghan, MD,‡ Nima Dehghani, DDS,§
 Siavash Dehghani, MD||

Abstract: Pseudoaneurysm of superficial temporal artery (STA) is an uncommon complication of blunt and penetrating trauma. It accounts for only 1% of all traumatic aneurysms. Most pseudoaneurysms of STA present as a painless pulsating mass, and its diagnosis can be made with physical examination and ultrasound or computed tomography angiogram. The treatment of choice is ligation and resection. This report includes a review of the anatomy, histopathology, etiology, diagnosis, and treatment options for STA pseudoaneurysm and presents a very rare documented case of STA pseudoaneurysm following penetrating trauma that was presented to the hospital with severe hemorrhage, and surgical resection of the lesion mandated the external carotid artery to be exposed for proximal control.

Key Words: Penetrating wounds, superficial temporal artery, pseudoaneurysm, hemorrhage

Pseudoaneurysm of the superficial temporal artery (STA) is an infrequent lesion resulting from head and facial trauma in the

From the *Department of Oral and Maxillofacial Surgery, Dental Research Center, Dental School, Shahid Beheshti University of Medical Science; and Departments of †Vascular and Transplantation ‡Radiology, and §Oral and Maxillofacial Surgery, Taleghani Hospital, Tehran; and ||Department of Neurosurgery, Poursina Hospital, Rasht, Iran.

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Address correspondence and reprint requests to Nima Dehghani, DDS, Department of Oral and Maxillofacial Surgery, Taleghani Hospital, Parvaneh Avenue, Velenjak Street, Tehran, Iran 1985711151; E-mail: nimadt2002@gmail.com

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frontotemporal region.^{1,2,4,5,7} It was first described in 1740 by Thomas Bartholin, and since then, more than 400 cases have been reported in the literature. It accounts for only 1% of all traumatic aneurysms.^{2–6} Most cases (about 75%) are the result of blunt head injury, but there are also cases related to iatrogenic trauma and penetrating trauma.^{2,3,5,6,16} We report a case of pseudoaneurysm of the STA secondary to penetrating face injury and discuss its etiology, pathophysiology, diagnosis, and treatment options.

CLINICAL REPORT

A 25-year-old man was referred to our emergency department with pulsatile hemorrhage from left preauricular region. The patient had been inadvertently injured by rivet gun and was inadequately managed at a local clinic just by cleansing and dressing. After 2 weeks, while bathing, he experienced marked hemorrhage from the wound and was taken to a hospital. Bleeding was controlled, and the wound was sutured. Two weeks later, he had another episode of arterial hemorrhage from the wound and was referred to our hospital.

After stabilizing the patient, he was admitted for further investigation. There was a 15-mm left preauricular wound with arterial bleeding, which was controlled by compression dressing (Fig. 1). The patient did not complain of headache or pain and showed no neurologic deficit. Medical history was unremarkable, and laboratory studies revealed normal blood cell count and normal coagulation tests.

Panoramic view of the mandible and posteroanterior skull x-ray revealed a small metallic foreign body in the left temporomandibular region (Fig. 2). Doppler sonography showed aneurysmal dilatation of a branch of external carotid artery, probably the STA (Fig. 3). Computed tomography (CT) angiography revealed 12 × 23 × 15-mm oval pseudoaneurysm arising off the main trunk of the left STA just posterior to the 5-mm metallic foreign body, which was lodged posterior to the mandibular condyle (Figs. 4 and 5). Based on these findings, proximal and distal ligation and resection of the pseudoaneurysm under general anesthesia were considered.



FIGURE 2. Panoramic radiographic view of the patient that shows 5-mm metallic foreign body near the left mandibular condylar region.