The *Pectoralis Major* Myocutaneous Flap

A Versatile Flap for Reconstruction in the Head and Neck

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The surgical treatment of advanced carcinomas of the head and neck area often requires extensive resections, necessitating large flaps for reconstruction. In recent years, there has been more acceptance of immediate repairs following the removal of these large cancers. As a result, patients are more willing to undergo these extensive resections to improve their chances of cure, with the reasonable expectation that an immediate reconstruction will provide an adequate cosmetic result.

If the cancer has progressed beyond any hopes for cure, sometimes palliative surgery with repair may be offered to lessen the suffering.

Repairs in the head and neck area have been facilitated by the recent development of myocutaneous flaps. In this paper we present our experience with a newly developed *pectoralis major* myocutaneous flap.

ANATOMY

Fresh cadavers were dissected to determine the blood supply to the *pectoralis major* muscle (PM). The muscle bundles run horizontally across the chest in the cephalad portion of the *pectoralis major,* while in the caudad portion the bundles take an oblique course from the acromion to the sternum and xiphoid.The dissections demonstrated that the major blood supply is derived from the thoracoacromial artery, with additional circulation provided by the highest thoracic artery and the lateral thoracic artery.

The thoracoacromial artery, a branch of the subclavian, traverses laterally under the clavicle for 2 to 4 cm before taking an oblique course immediately lateral to an axis from the acromion to the xiphoid (Fig. 1, *left*). As such, this vessel runs along an axis parallel to the muscle bundles of the midportion of the overlying PM. The thoracoacromial artery is accompanied along its course by its corresponding vein and by one of the motor nerves to the *pectoralis major,* the lateral pectoral nerve (lateral anterior thoracic nerve) from the brachial plexus (Fig. 1, *right*). It should also be noted that the thoracoacromial artery gives off proximal branches which need to be divided at the time of dissection. These vessels are readily demonstrated by arteriography (Fig. 2).

OPERATIVE TECHNIQUE

The muscle is approached through an incision in the anterior chest, just lateral to a line drawn from the acromion to the xiphoid (Fig. 3). The pectoral fascia is incised, the muscle bundles are split along their fibers, and the muscle medial to the incision is elevated off the chest wall by blunt finger dissection. With the muscle elevated by retractors, the neurovascular bundle can be visualized easily along the undersurface of the PM (Fig. 4, *left*). Once the neurovascular bundle is identified, the incision is extended inferomedially, parallel to the vessels. The vessels must be kept under direct vision throughout the entire dissection to avoid damage to them.

The muscle pedicle and the overlying skin are dissected as wide as one needs for the defect being repaired. As the dissection is carried proxi-

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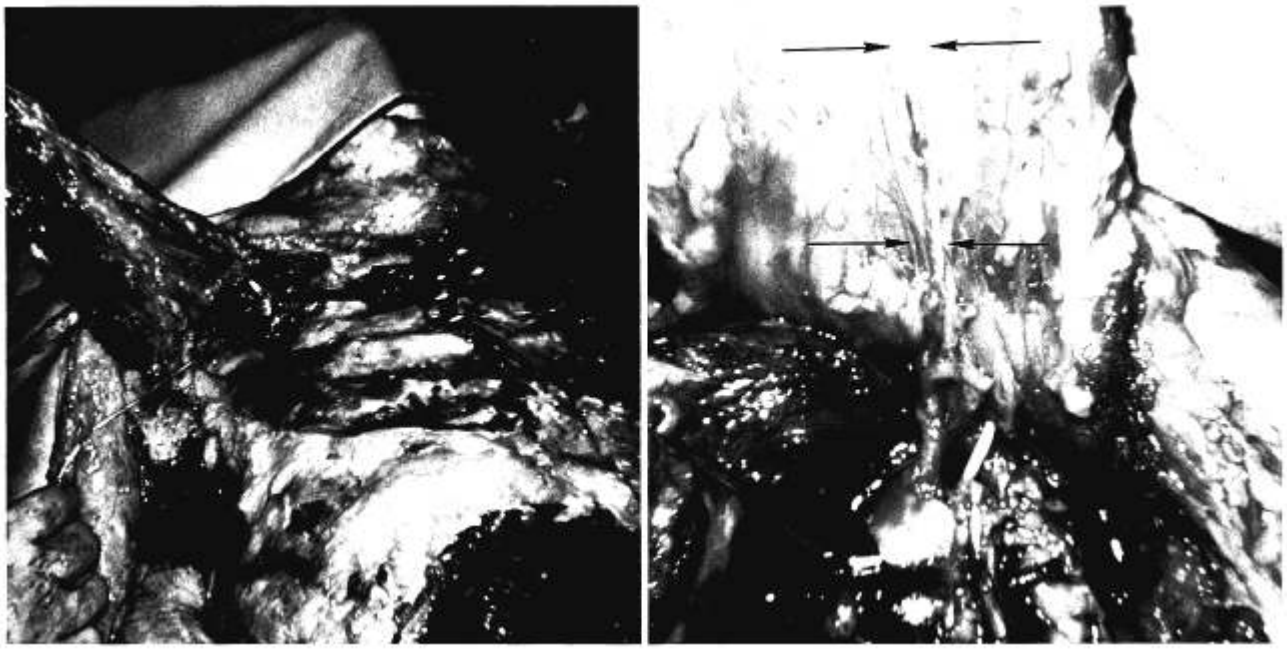

FIG. 1. Fresh cadaver dissection. (*left*) The muscle elevated from the chest wall, showing the axial direction of the thoracoacromial vessels and the lateral pectoral nerve. (*right*) Close-up, showing the vessels and the nerve.

FIG. 2. An arteriogram, showing the thoracoacromial artery (*TA*) branch from the subclavian artery (*SC*).

mally, the lateral branches of the thoracoacromial vessels are divided and ligated. The muscle pedicle may be dissected as far proximally as is necessary, and the clavicular portion may be separated from this bone to provide further mobility. In fact, the lateral tendinous portion may also be divided to provide a true "island" pedicle, remaining attached only by the neurovascular bundle (Fig. 5). This provides even greater mobility, without any compromise to the circulation of the flap.

Finally, to close the donor defect we undermine and advance the lateral portion of the chest wall (Fig. 4, *right*).

CASE REPORTS

Case 1

An 82-year-old man with proptosis and destruction of his right globe from a sebaceous gland carcinoma underwent orbital exenteration. The patient had been very concerned about the deformity of the planned procedure, and he did not want further scars from local flaps.

A PM myocutaneous flap was elevated, measuring 6 × 30 cm, with its neurovascular bundle (Fig. 6). The flap was tested with intravenous fluorescein, and was found to have excellent perfusion. Therefore, the full thickness of the skin over the distal 6 cm was removed; then the underlying muscle and soft tissue provided the bulk to fill the orbit, while the skin edges were sutured to the margins of the defect. The pedicle was divided and the flap was inset 13 days later.

Case 2

A 74-year-old woman had painted watch dials with radium for many years, during which she ingested radio-

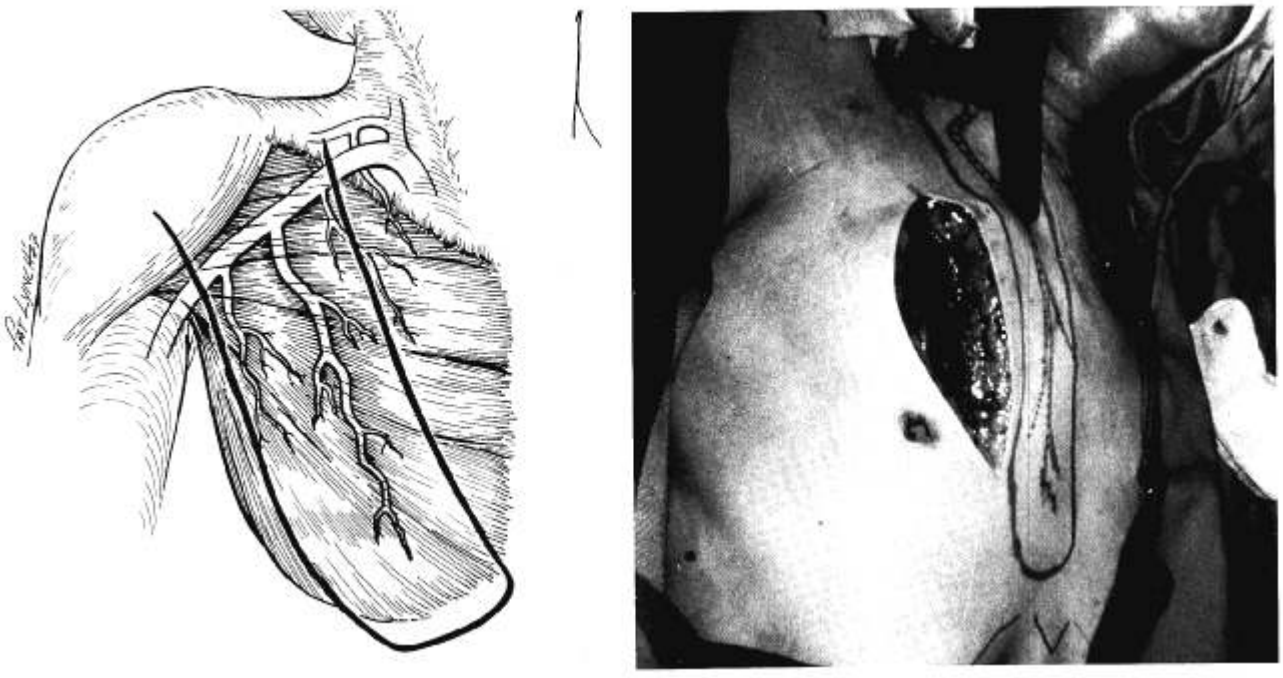

FIG. 3. (*left*) The myocutaneous *pectoralis major* flap. (*right*) The initial incision is along the lateral border, the muscle fibers are split, and then the muscle flap is raised from the chest by blunt dissection under the PM.

active fluorescent paint. This resulted in deposition of radioactive material in all the bones of her body, with consequent malignant transformations in the paranasal sinuses and overlying skin.[5]

During the two years before we saw her, she had been treated with courses of radiation therapy on 3 occasions for recurrences in the right orbital region. Then she was referred for possible orbital exenteration and repair, because of constant severe pain.

On examination, there was a destroyed globe, exposed infected bone, and persistent tumor in the wound. An ACTA scan revealed destruction of the bony borders of the orbit, as well as the right sphenoid and ethmoid sinuses.

A radical exenteration of the orbit was performed through a craniofacial approach, removing the floor of the anterior fossa and the adjacent dura. The dural defect was closed with a fascial graft. We closed the nasal vestibule off from the surgical defect by using a mucoperichondrial flap from the nasal septum.

A PM myocutaneous flap was elevated, 6 cm wide and extending from the acromion to the xiphoid. The donor site was closed primarily. A strip of the entire length of muscle was freed parallel to the neurovascular bundle, left attached at its distal 8 cm, and used to fill the large cavity at the operative site (Fig. 7). The surface of the defect was covered then with the skin of the flap. The pedicle was divided and the flap inset 20 days later.

Case 3

A 62-year-old male had been referred for treatment of a large squamous cell carcinoma of the right floor of the mouth. Unfortunately, he had had an excisional biopsy of a jugolodigastric node in his right neck prior to this referral, and this wound was fixed to the underlying sternocleidomastoid muscle—precluding its use for reconstruction.

He was treated by resection of the right floor of the mouth, the right tongue, the right anterior tonsillar pillar, and the right lower alveolar ridge (wih a partial rim mandibulectomy)—plus an in-continuity right radical neck dissection through a modified McFee neck incision.

A 5 × 8 cm "paddle" of skin was elevated from the lower medial chest on a 6 × 22 cm "island" of PM, attached only by the neurovascular bundle (Fig. 5). This was passed over the clavicle, under the neck flap, under the mandible, and then inset into the defect in the oral cavity (Fig. 8). The entire procedure was performed in one stage. He began eating on the seventh postoperative day, and he began a full course of postoperative radiation therapy at two weeks.

Case 4

A 62-year-old male was referred for treatment of a recurrent squamous cell carcinoma of the left tonsil. He had been treated in another city with a left radical neck dissection for a metastatic neck node, with no known primary at that time. The tonsillar carcinoma had been identified later and treated with a full course of radiation, through both sides of his face.

At this referral, he was found to also have a squamous carcinoma of the right anterior floor of the mouth, with induration of the right buccal region. Biopsies of the buccal region prior to surgery were negative for tumor.

At the operation, the left tonsillar region was resected, with frozen section confirmation of a wide clear margin.

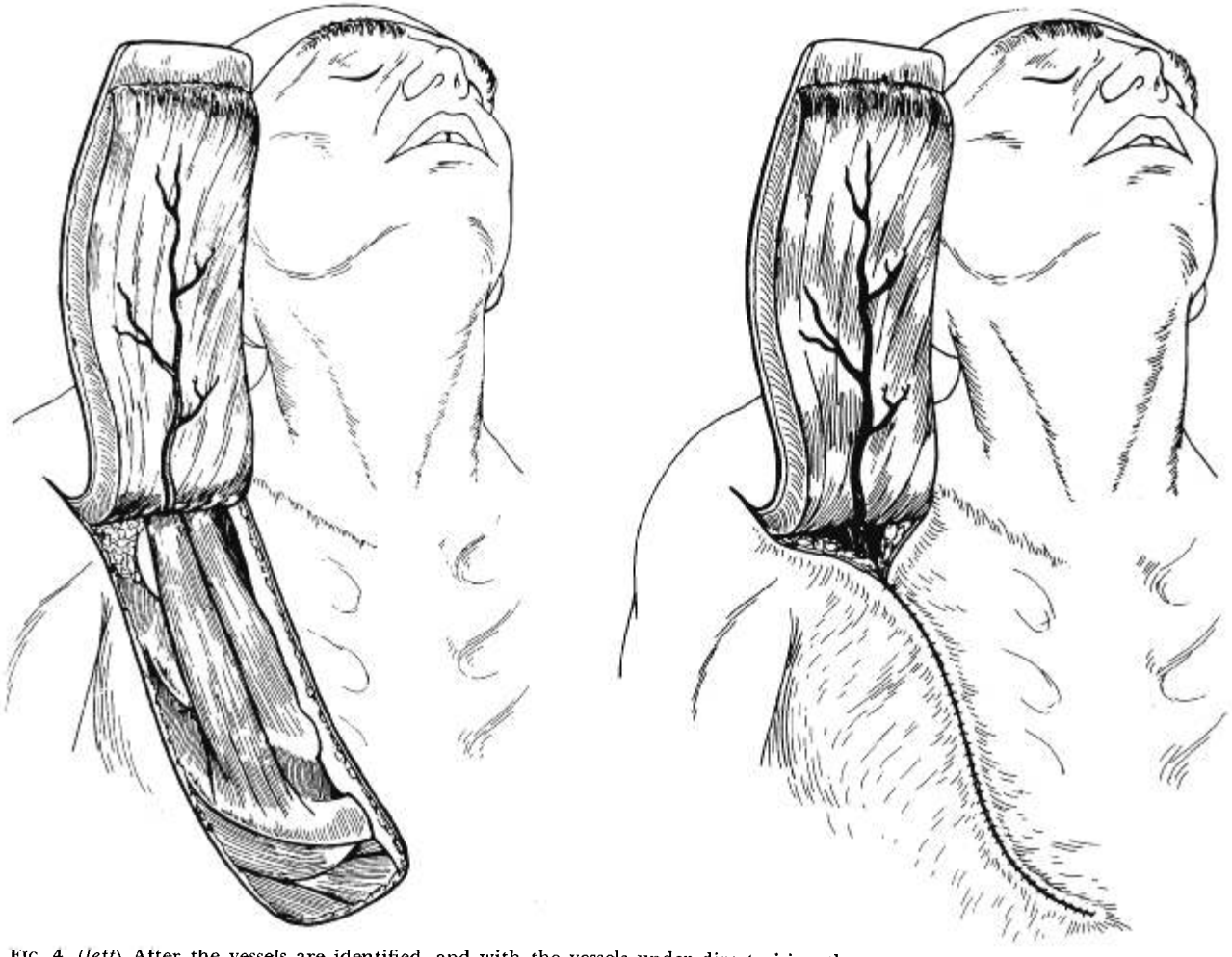

FIG. 4. (*left*) After the vessels are identified, and with the vessels under direct vision the myocutaneous flap is elevated. (*right*) The donor site is closed by undermining and advancement of the lateral edge of the wound.

The right floor of the mouth was resected together with a portion of the adjacent undersurface of the tongue; a rim mandibulectomy was done with an in-continuity right radical neck dissection, through a modified McFee incision. Frozen section examinations of the depth of the wound showed malignancy within areas of radiation change. As a result, a wide section of the upper neck skin had to be removed (Fig. 9, *above left*).

Skin was needed to resurface the upper neck, as well as to line the mouth defect. Therefore, two 6 × 8 cm "paddles" of skin were elevated on a segment of PM muscle 6 cm wide and extending from the acromion to the xiphoid (Fig. 9). To attain full mobility, the muscle was freed of all its attachments except for its neurovascular pedicle. Then it was passed over the clavicle and under the neck flap, and the more proximal "paddle" of skin was used to cover the upper neck defect. The distal portion of the flap was put into the oral cavity to cover the rim of the mandible with the PM muscle, and to line the mouth defect with the distal "paddle."

The donor defect on the chest was closed by an advancement flap.

The entire excision and the reconstruction were performed in one operation.

DISCUSSION

There has been a high incidence of complications in extensive operations for cancer of the orbit and/or paranasal sinuses. The combined craniofacial approach to these tumors has diminished the problems somewhat,[6] but the complication rate remains high—with cerebrospinal fluid leaks in half the patients and infection in almost all of them.[7] This may be related to covering the defects with split-skin grafts, which may not afford much protection since they often do not take completely in this area. We may anticipate that the use of healthy flaps to cover these defects

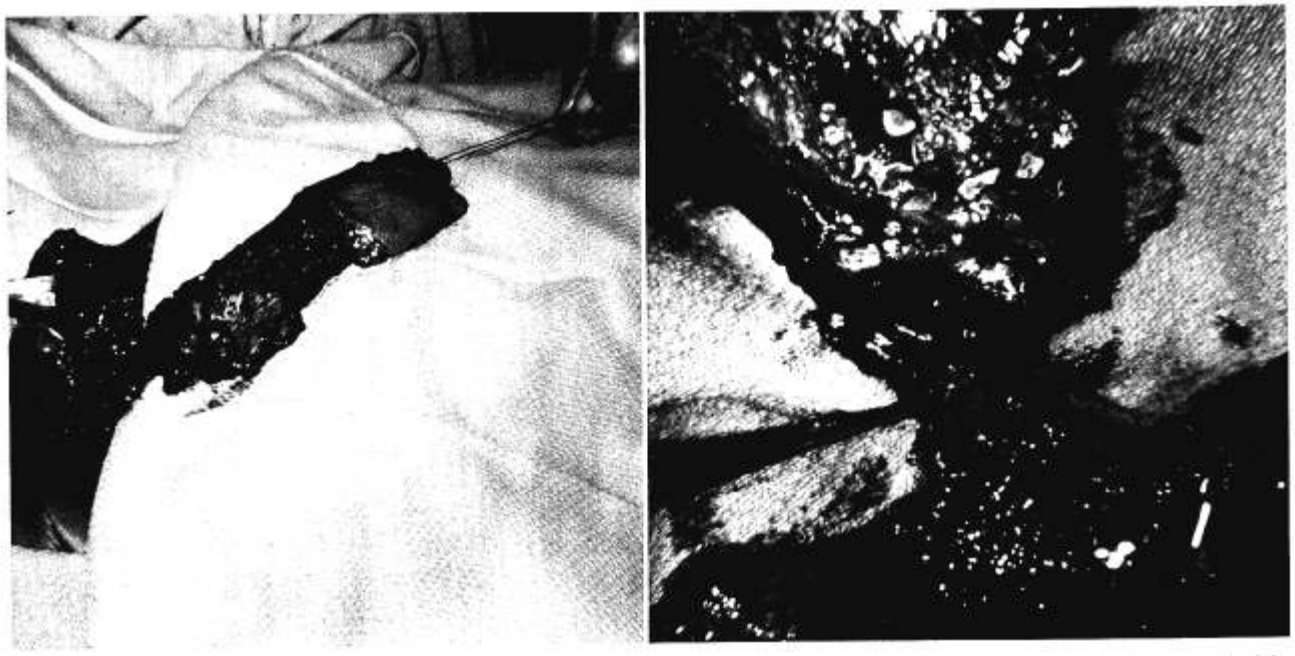

FIG. 5. (*left*) Here, the elevated PM muscle flap carries a "paddle" of skin while the muscle has been detached from the clavicle and insertions to give the flap maximum mobility. (*right*) Close-up, showing the attachment to be essentially the neurovascular bundle surrounded by connective tissue.

FIG. 6. *Case 1.* (*left*) PM myocutaneous flap elevated, with the skin removed from the distal 6 cm (which is going inside the orbit). (*center*) The flap at 13 days, with the fluorescein test showing good circulation while the pedicle was clamped. (*right*) Result.

would not only seal the area against CSF leaks, but would also afford more protection against bacterial invasion.

In addition, the deformity resulting from a skin-grafted defect after a craniofacial resection may be too great. Although the prognosis in these tumors is often poor, and there is no agreement on the best method to treat them, there have been attempts to provide reasonably good cosmetic results.

Thomson[8] reported the use of an ipsilateral forehead flap to provide coverage of an orbital exenteration, after the defect was filled with absorbable gelatin sponges. He also pointed out that most of the flap could be returned to the donor site, leaving some underlying soft tissue over the orbit which could then be skin grafted—much

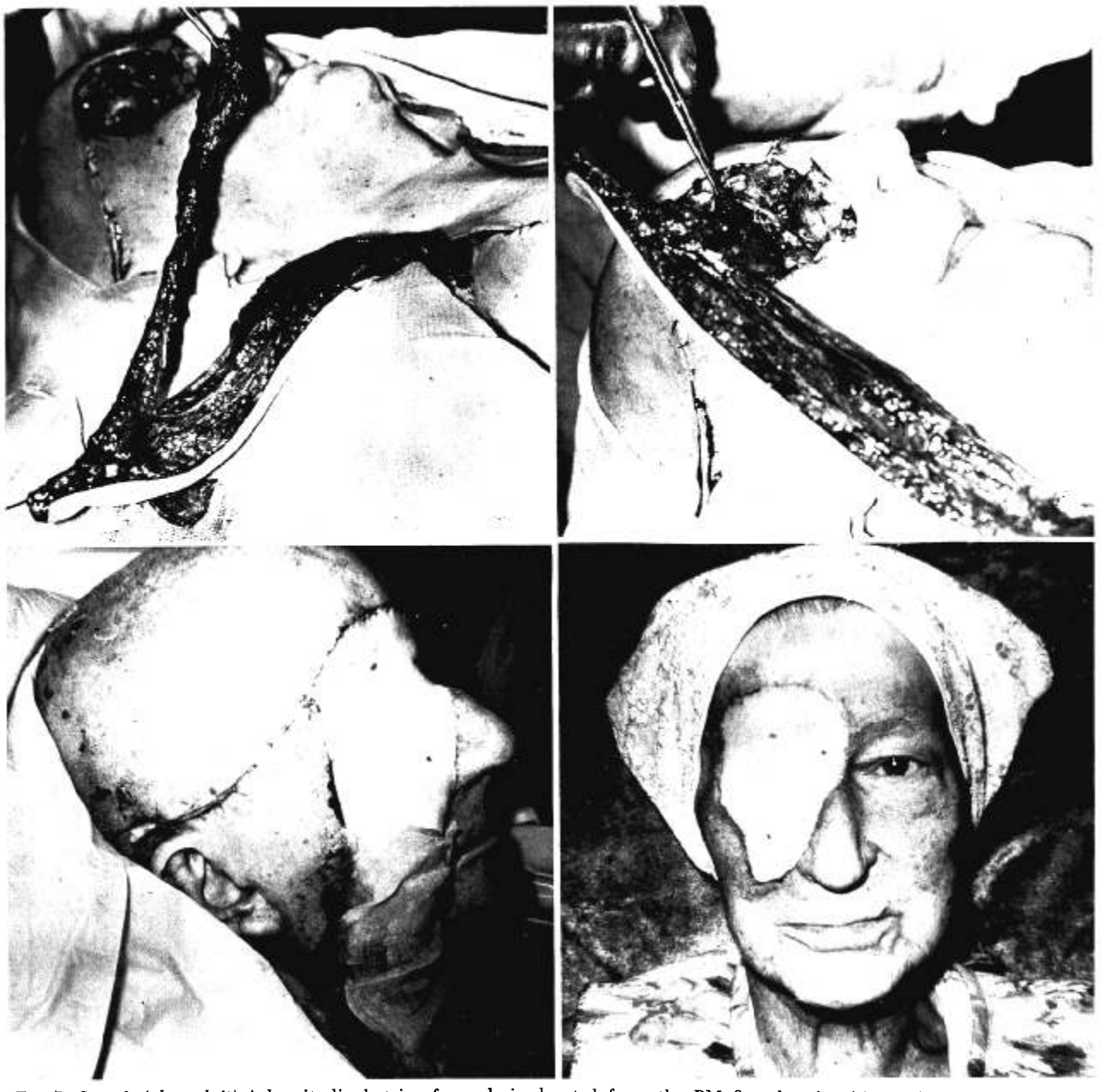

FIG. 7. *Case 2. (above left)* A longitudinal strip of muscle is elevated from the PM flap, but is still attached distally to carry the intact vessels. *(above right)* The muscle strip is used to fill the orbital cavity. *(below left)* Craniotomy flap replaced, PM myocutaneous flap in place. *(below right)* Result.

like the "crane principle" of Millard.[9] However, one might question the placing of a foreign body in an area contaminated with bacteria from the sinuses, particularly as these operations are often associated with CSF leaks.

Another method has been the use of a *temporalis* muscle flap to fill the defect after an orbitomaxillary resection.[10] The muscle may fill the cavity, and it may then be covered by a split-skin graft or by a flap. However, the use of a local flap may produce additional local deformity, and sometimes the surrounding tissue may not be suitable for a rotation flap because of previous radiation.

Distant flaps have some advantages for these repairs.

The PM muscle has been used locally on the chest to a limited extent in the past. Pickrell, Baker, and Collins[11] have used the PM, and other chest wall muscles, as local, small, turn-over flaps to reconstruct chest wall defects.

FIG. 8. *Case 3. (left)* The "paddle" of skin on the PM muscle flap, which is attached only by the neurovascular bundle (see Figure 5), after tunneling through under the neck flap. *(center)* The "paddle" of skin was used to reconstruct the missing mouth lining—shown here at 21 days. *(right)* The PM muscle flap restores the prominence of the missing sternocleidomastoid muscle (following the right radical neck dissection).

The laterally-based deltopectoral flap was introduced by Conley [12] 25 years ago to resurface defects of the chest or neck, but it was used as a skin flap only. Its advantages are that it furnishes a large surface area, and it may be elevated without a previous delay. Its disadvantages are that it has to have a wide base at the shoulder, and consequently a large defect, and it is too short to travel any higher than the neck.

Hueston and McConchie [13] combined this skin flap with the underlying *pectoralis major* muscle to repair a large defect that resulted from a resection of the upper sternum and the first and second costal cartilages. However, the design of their compound flap is such that it suffers the same disadvantages as the skin flap alone.

Pollock, Bitseff, and Ryan [14] modified the laterally-based deltopectoral flap by tubing the shoulder portion and delaying the medial chest "paddle" once or twice to obtain a long flap that would reach the cervicofacial region. Unfortunately, this required 21 days and 2 to 3 operations to prepare the flap for use.

The medially-based deltopectoral flap developed by Bakamjian [3] has been a most versatile one. Based medially on the intercostal perforating vessels of the internal mammary artery, it is an axial flap that can be elevated to the shoulder without delay. However, this flap requires a wide base to get this length, it requires skin grafting to close the donor site, it does not provide enough bulk to fill in large defects, and it will not reach the upper limits of the orbit or forehead without a delay to lengthen the tip of the flap.

By contrast, the PM myocutaneous flap is an axial flap that may be elevated for some distance on its vessels alone, but it has been elevated with a strip of the muscle to provide safety and bulk. It has enough bulk to fill cavities, to augment contour, and to provide structural support in one step. It is redundant enough (Fig. 7) to reach not only the depths of the orbital cavity, but also to reach the frontal, parietal, and temporal regions. It has excellent vascularity in the muscle pedicle, due to the axial vessels—and it can provide proper nourishment to any fascial grafts used to close dural defects. (In fact, our earlier experience with sternocleidomastoid muscle flaps has shown that the circulation in muscle is sufficient to successfully transport skin "paddles" even on muscle pedicles that have been exposed to large doses of radiation therapy.) The intact motor nerve, that is transferred with the pedicle of PM muscle, may also tend to prevent its later atrophy and contraction.

The PM flap may be elevated on a narrow strip of muscle, and this muscle may also serve to replace a resected sternocleidomastoid muscle and thus restore symmetry to the neck (Fig. 8, *right).* Finally, by removing the skin from over the buried portion of the pedicle, the reconstruction can be finished in one stage—eliminating later pedicle division and inset of the flap. Unless a very large flap is elevated, the donor site can be closed primarily by the advancement of adjacent skin.

As to its potential uses, we anticipate that very large areas of tissue may be obtained from this site because the underlying PM muscle itself

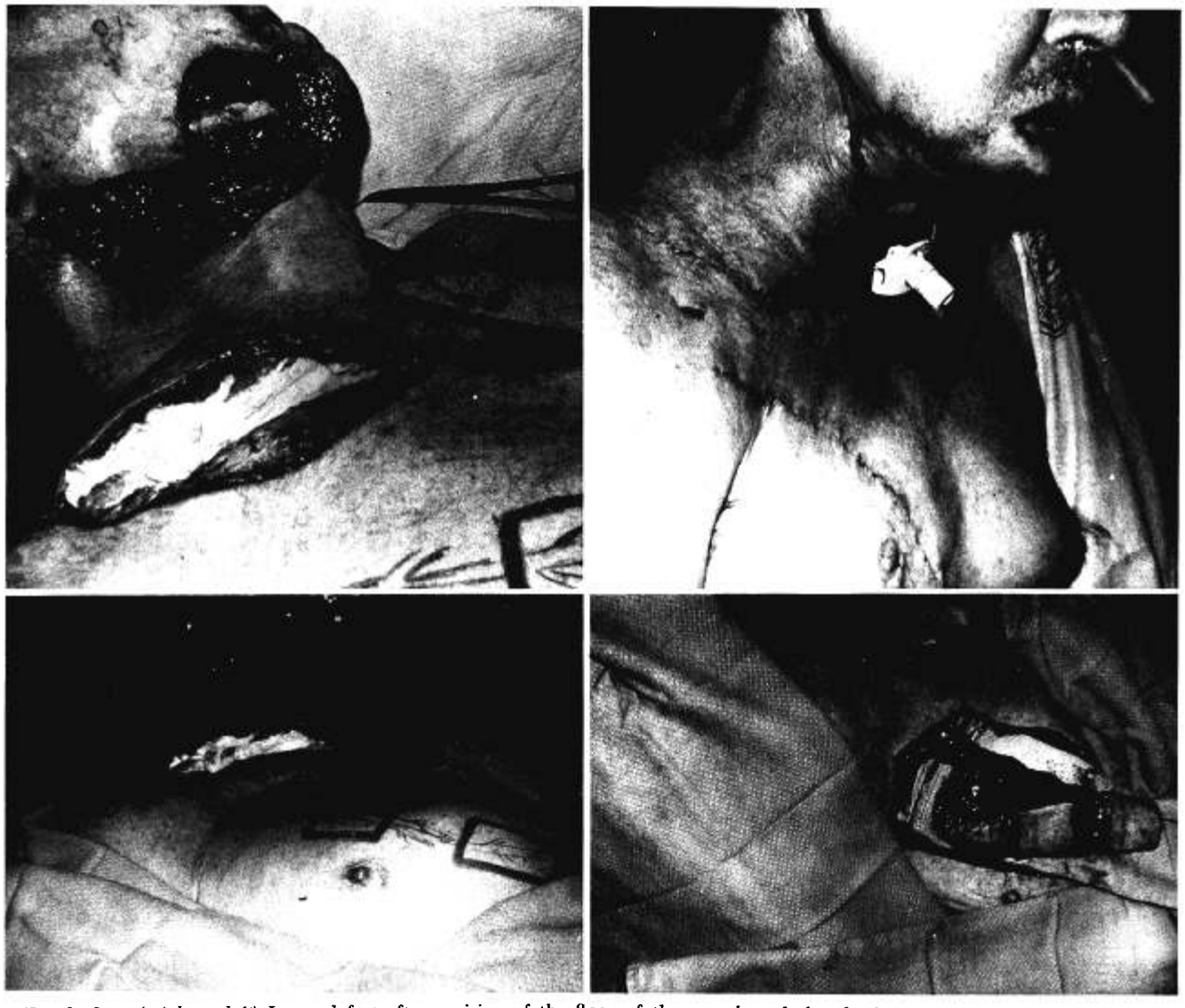

FIG. 9. *Case 4.* (*above left*) Large defect after excision of the floor of the mouth and the cheek, a rim mandibulectomy, and a radical neck dissection. (*below left*) Two "paddles" of skin are designed over the axial vessels of the PM muscle flap. (*below right*) The muscle flap is dissected free, except for the neurovascular bundle; all the skin is removed except the two "paddles." (*above right*) In the reconstruction, the PM flap was tunneled under the neck flap and the distal skin "paddle" was used to replace the missing oral mucosa, while the proximal "paddle" was used to replace the missing skin from the upper neck.

has a large surface area, and it has an excellent axial blood supply. Furthermore, because it has an excellent neurovascular pedicle, this flap may also be useful as the source for a large composite free flap.

SUMMARY

A compound flap is described that utilizes skin from the anterior chest on a narrow segment of *pectoralis major* muscle, with its underlying axial neurovascular bundle. This flap has been used successfully to reconstruct large defects in 4 consecutive patients. Our experience with this flap suggests that it may be more versatile than the deltopectoral flap.

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