The use of the pectoralis major myocutaneous island flap for reconstruction after major ablative head and neck surgery

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Summary

The anatomy of the pectoralis major myocutaneous island flap and the technique and history of its use in reconstruction after major ablative head and neck surgery are described. Twelve cases illustrating the indications for use of the flap and the surgical applications, complications and results are reported. In the future we may expect great advances in this field due to the versatility and reliability of the flap.

The late 1970s have seen the introduction of a new era in surgical reconstruction in general and in reconstruction after head and neck surgery in particular. The harbingers of this era were the muscle/skin (myocutaneous) flap. In this paper 12 cases in which pectoralis major myocutaneous flaps were used for various aspects of head and neck reconstruction are reviewed.

Although the first report of a muscle/skin flap appeared as long ago as 1896 and other isolated reports followed, it was not until 1977 that the basic structural features and usefulness of the pectoralis major myocutaneous (PMMC) flap were reported. Since then these flaps have become almost universally applied in major head and neck surgery centres in North America, and no head and neck surgeon should be unaware of their advantages and of the technique involved.

The last great contribution to head and neck reconstructive surgery was made by Bakamjian in 1965 with the introduction of the deltopectoral flap; this became the workhorse of head and neck reconstruction, and its usefulness has been considerably enhanced, not replaced, by the PMMC and other myocutaneous flaps (the sternocleidomastoid, trapezius and latissimus dorsi flaps, with which this report will not deal further).

The basic circulation in skin flaps is depicted in Fig. 1. The distinction between axial and random pattern flaps was defined by McGregor. An axial pattern flap has an anatomically recognized arteriovenous circulation which follows the long axis of the flap. An island flap has a pedicle based on this circulation. The middle horizontal column and the lower one represent myocutaneous flap circulation. The lower column is schematic. Myocutaneous flaps depend for their blood supply on segmental vessels which give off perforators, which communicate via the musculocutaneous vessels with the dermal-subdermal plexus.

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The basic circulation in skin flaps is depicted in Fig. 1. The distinction between axial and random pattern flaps was defined by McGregor. An axial pattern flap has an anatomically recognized arteriovenous circulation which follows the long axis of the flap and gives off branches to the dermal-subdermal plexus (Fig. 1). The viable length of this flap is not related to its width but rather to the length of the specific axial vessel included in the flap. In contrast, a random pattern flap has no axial arteriovenous system and derives its nutrition solely from the communication of vessels in the dermal-subdermal plexus. Its maximum viable length, which may vary with its location in the body, is related to its width.

The circulation in a myocutaneous flap can be better understood by visualizing the arterial blood supply (Fig. 1) as being distributed to the skin by direct cutaneous vessels and indirectly by segmental via perforating vessels. The segmental vessels are related to the course of nerves and run deep to the muscle masses. They provide perforator vessels (e.g., the perforators of the internal mammary artery) which supply the muscles and communicate with the cutaneous vessels. These communications are known as the musculocutaneous vessels; they are the innumerable delicate vessels passing from the muscle masses to the subcutaneous tissue of the overlying skin.

In contrast, some cutaneous vessels communicate directly with the segmental vessels and do not pass through a major muscle mass in doing so. There are therefore two types of cutaneous vessel supply: direct vessels and musculocutaneous vessels. The viability of myocutaneous flaps is based on the preservation of the delicate musculocutaneous vessels and the segmental vessels supplying the particular muscle.

Subjects and methods

The 12 patients (Table 1) were chosen for this report because of my personal experience with them and because these cases exemplify the use of the PMMC flap.
### TABLE I. USE OF THE PECTORALIS MAJOR MYOCUTANEOUS ISLAND FLAP IN 12 PATIENTS

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age (yrs)</th>
<th>Lesion</th>
<th>Radiation</th>
<th>Surgical procedure</th>
<th>Flap used for</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>64</td>
<td>Pyriform fossa (T2N1)*</td>
<td>700 rad pre-op.</td>
<td>Laryngopharyngectomy (L), RND</td>
<td>Total pharynx reconstruction</td>
<td>After initial fistula healed well; 4 mo. later cancer recurred inferiorly</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>63</td>
<td>Tongue base (R) (T2N1)</td>
<td>^60Co DXT, needle implants</td>
<td>Composite resection (R)</td>
<td>Floor of mouth and tongue reconstruction</td>
<td>Excellent; well 9 mo. after surgery (Fig. 3)</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>61</td>
<td>Retromolar trigone (R) (T2N1)</td>
<td>^60Co DXT</td>
<td>Composite resection (R)</td>
<td>Oropharyngeal reconstruction</td>
<td>Excellent; well 8 mo. after surgery (Fig. 4)</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>53</td>
<td>Tonsil (L) (T2N1)</td>
<td>^60Co DXT</td>
<td>Composite resection</td>
<td>Oropharyngeal reconstruction</td>
<td>Initial good result; radionecrosis of mandible at 4 mo.; local recurrence at 5 mo.</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>66</td>
<td>Larynx, LVC (T2N1)</td>
<td>^60Co DXT</td>
<td>Total laryngectomy (L), FND</td>
<td>Closure of large pharyngocutaneous fistula</td>
<td>Excellent; healed primarily</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>65</td>
<td>Lower lip (T2N1)</td>
<td>Nil</td>
<td>Resection lip + mandible (FND)</td>
<td>Lip + facial skin mandible with forehead flap for total reconstruction (rib graft)</td>
<td>Rib viable 2 mo. after surgery. Still having surgery to complete reconstruction</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>50</td>
<td>Retromolar trigone (T2N1)</td>
<td>^60Co DXT</td>
<td>Composite resection</td>
<td>Oropharyngeal reconstruction</td>
<td>Good healing and function</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>52</td>
<td>Inf. alveolus (L)</td>
<td>Nil</td>
<td>Composite resection</td>
<td>Oral reconstruction</td>
<td>Healed well; excellent tongue mobility</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>68</td>
<td>Larynx</td>
<td>^60Co DXT</td>
<td>Total laryngectomy</td>
<td>Multiple pharyngocutaneous fistulas</td>
<td>Flap healed well; small fistula persisted but healed in 3 wks</td>
</tr>
<tr>
<td>10</td>
<td>F</td>
<td>55</td>
<td>Pyriform fossa (T2N1)</td>
<td>^60Co DXT</td>
<td>Pharyngolaryngectomy</td>
<td>Total pharyngeal reconstruction</td>
<td>Primary healing in 2 wks; late secondary fistula</td>
</tr>
<tr>
<td>11</td>
<td>M</td>
<td>81</td>
<td>Tonsil (L) (T2N1)</td>
<td>Nil</td>
<td>Composite resection</td>
<td>Oropharyngeal reconstruction</td>
<td>Excellent primary healing</td>
</tr>
<tr>
<td>12</td>
<td>M</td>
<td>58</td>
<td>Larynx</td>
<td>^60Co DXT</td>
<td>Total laryngectomy</td>
<td>Large wound dehiscence + pharyngocutaneous fistula</td>
<td>Flap healed well; fistula persisted but closed with dressings</td>
</tr>
</tbody>
</table>

* TNM classification is according to the International Union against Cancer (Geneva, 1978).

RND = radical neck dissection; FND = functional neck dissection; DXT = radiation therapy (all patients received a full curative course, approx. 5,000 rad, except where stated); R = right; L = left; composite resection = ‘commando procedure’, i.e. resection of tumour + mandible + neck dissection; LVC = left vocal cord.

### Surgical technique

The surgical technique can be understood by referring to Fig. 2. The pectoralis major (PM) muscle is a fan-shaped muscle covering the upper chest; the fibres run horizontally in the upper portion (clavicular fibres) and obliquely in the lower portion (sternocostal fibres). Ariyan demonstrated by fresh cadaver dissection that a large segmental blood supply was present from the thoraco-acromial artery. This vessel pierces the clavipectoral fascia above the pectoralis minor and courses on the undersurface of the PM muscle in the axis of a line drawn from the acromion to the xiphisternum (Fig. 2). Other smaller vessels are included in the ‘random’ portion of the flap, and their viability is less secure than the axial portion.

The paddle should be situated medial to the nipple, but may include the nipple if this is essential. It should lie along the acromio-xiphisternal line as shown in Fig. 2 and should not extend further inferiorly than the 6th rib, because this is the most inferior attachment of the PM in most cases. The highest point which the flap can reach is this inferior limit pivoted about a point below the mid-clavicle, since the thoraco-acromial artery pedicle has to curve over the clavicle at this point. Usually the flap will reach the zygomatic arch.

Having decided upon the exact limits of the skin paddle, the skin can be incised down to the deep fascia overlying the PM muscle. The incision should not be extended into the muscle itself; this requires a great deal of care in thin subjects, especially at the upper margin of the skin paddle. Great care must also be taken and this is crucial to the viability of the flap not to damage the delicate musculocutaneous vessels by a shearing action of the skin, now mobilized, upon the underlying muscle. For this reason it has become standard practice in this centre to use a number of No. 4/0 chronic catgut sutures from the subcutaneous tissue to the fascia over the PM muscle to prevent this.

When this has been accomplished, the skin around the paddle is mobilized as far as the midline, the mid-axillary line, the costal margin and the clavicle. At this stage it is helpful to extend the

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* SA MEDICAL JOURNAL 22 MAY 1982"
incision from the upper outer corner of the skin flap towards the neck of the humerus. Care should be taken not to injure the skin above this area, as it is still possible to use the skin above the paddle for a synchronous or metachronous deltopectoral flap. Once the lateral edge of the PM muscle has been exposed, the space beneath can be developed by opening the fascial plane with sharp dissection and then inserting a finger, which is carefully swept up and down, separating the fascia below the PM from the pectoralis minor muscle. The pectoral branch of the thoraco-acromial artery runs in the fascia along the undersurface of the PM muscle. It can now readily be palpated by feeling with the dissecting finger in the expected area along the axis described. Excessive palpation should be avoided, as it is possible to cause spasm. The sternocostal fibres are next divided by using sharp dissection, so that the muscle belly is reflected superiorly and the vascular pedicle seen. At this stage the technique is modified according to the requirements. If much bulk is required, the whole muscle is taken; if less bulk is desirable, only the portion of muscle below the skin is required.

Having severed the sternocostal origin of the PM muscle, the entire humeral insertion must be severed also. This must be lateral to the axis described, but need not be excessively close to the humerus. Here again the width of the pedicle can be adjusted according to requirements. Strictly speaking it is only necessary to preserve the vascular pedicle, which should by now be clearly seen and may even be pulsating visibly. The muscle fibres (including the sternoclavicular fibres) are trimmed away using fine dissecting scissors, so as to make the pedicle as thin as required. A bulky pedicle may be desirable, for example if the carotid artery is exposed following radical neck dissection.

The basic flap has now been raised; the rest of the procedure depends on its exact use, of which there are examples in Table I. The flap is brought into the operative area in the neck, oral or pharyngeal area by mobilizing the intervening skin on the neck so that the skin paddle with its muscle attached is pulled through subcutaneously. The skin tunnel so produced should not exert any pressure on the vascular pedicle as it passes over the clavicle.

The defect left in the chest can be closed in virtually every case by primary suture. Provided that the mobilization of the surrounding skin has been sufficient, excessive tension should not be produced. We use tension sutures of No. 5 Tevdek tied over rubber bolsters. The area should be drained by suction catheters.

### Results

The outcome of the reconstructive procedures using PMMC flaps in the 12 patients is summarized in Table I. Two flaps were used for total pharyngeal repair, 4 for oropharyngeal reconstruction following composite resection of an oropharyngeal carcinoma (commando procedure), 3 to close large pharyngocutaneous fistulas caused by wound breakdown, and 2 for reconstruction of the floor of the mouth and tongue; 1 flap including a portion of the 5th rib was used for reconstruction of the mandible and skin of face and lip.

All of these 12 flaps proved viable and survived without breakdown of any portion.

In patient 1 there was tumour recurrence at the inferior resection margin, but the tubed PMMC flap survived and closed after initial fistula formation, providing an adequate pharynx until recurrence. Autopsy showed good mucosa-to-skin healing; there was no area of fibrous stricture. In patient 4, who underwent oropharyngeal reconstruction following resection of the left tonsil for carcinoma, healing was good but local tumour recurrence occurred 5 months postoperatively.

The flap has been used in 3 patients for the closure of large, intractable pharyngocutaneous fistulas. In centres in which radiation therapy is almost invariably used for primary treatment, formation of pharyngocutaneous fistulas following laryngectomy is not uncommon. Usually conservative therapy is sufficient, and most fistulas close within 3-4 weeks. Some, however, would take so long to heal that the patient would have to stay in hospital for months. We have found the PMMC flap invaluable for replacing poor neck skin (due to radiation) and closing the fistula while bringing soft, bulky, pliable skin into the area. It was used for this purpose in patient 5, with excellent results and primary healing. In patient 9 there was wound breakdown and fistula formation in a small area, but this closed within 3 weeks and the patient was able to be discharged. In patient 12 there was also some initial fistula formation, but this healed with dressings.

Of the 4 patients who received the flap for oropharyngeal reconstruction, all except 1 (patient 4, in whom the flap healed well but in whom the tumour recurred) have done well. In cases 2 and 3 more than 8 months have elapsed since reconstructive surgery was performed. Patient 2 underwent reconstruction of the posterior tongue and the floor of the mouth; she has therefore been listed under the latter category, but can also be considered to fall into the oropharynx (posterior one-third of tongue) category (Fig. 3). In this case restoration of speech and deglutition was good. The cosmetic result of reconstructive surgery using the PMMMC flap after a 'commando procedure' (6 cases) is excellent, as seen in Figs 3 and 4, owing to the fact that the muscle bulk fills in the defect left by resection of the mandible. The functional result is considerably better than in patients who have undergone primary closure, because the tongue is rendered mobile.

Patient 6 had an extremely large tumour of the lower lip involving the right commissure and mandible. This was resected primarily and right myocutaneous and right forehead flaps were used for reconstruction. A portion of the 5th rib was included in the muscle for replacement of the segment of anterior mandible. Six weeks postoperatively bone scan showed the bone to be viable. Healing has been good and the bone segment is stable.
No severe complications have been associated with the procedure. Disability resulting from the loss of muscle to the upper arm is minimal, and none of our patients have complained of it. Three patients (cases 1, 9 and 12) experienced some complications at the donor site. Patient 1 had a haematoma which was evacuated; he eventually required skin grafting to achieve closure. The other 2 patients developed effusions; patient 9 became infected and required drainage of pus; in patient 12 it resolved spontaneously.

Discussion

Although this is not a large series, these cases illustrate the use of a technique which has become extremely valuable during the last 3 years.

The PMMC flap does not replace any previous techniques but enhances them all, and in conjunction with the other myocutaneous flaps and the deltopectoral and local skin flaps enables the head and neck surgeon to perform operations which he has hitherto been reluctant to carry out in some cases, particularly when the patient has received previous radiation therapy.

The technique has several inherent advantages. It is by and large a one-stage procedure. No split-skin grafts are needed to close the defect from the donor site, because this is closed primarily. The bulk of the muscle is extremely useful; it can fill defects left by bone resection (e.g. mandible or temporal bone) or cover major vessels which have been exposed by neck dissection. The muscle is also useful in providing healthy, well-vascularized tissue to help in sealing in fistula repair. The flap paddle can be
The operative management of acute post-pneumonectomy bronchopleural fistula after flush bronchial amputation

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Summary

Acute disruption of the bronchial closure after pneumonectomy causes severe problems in patient management. Radical attempts at closure of the fistula and space obliteration (thoracoplasty) carry a high mortality. The management of this condition by a series of staged operative procedures is described. Pneumonectomy has usually been performed for bronchogenic carcinoma and prognosis is therefore guarded. Several low-risk operative interventions, with discharge from hospital between procedures, provide a safe and effective management method in the case described.


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Acute disruption of the bronchial closure following pneumonectomy is fortunately an uncommon event.\(^1\)\(^\text{1,2}\) It occurs about 10 days postoperatively and infection of the post-pneumonectomy space usually follows. The correction of this grave complication requires initial prompt supportive therapy and a series of planned operative interventions. Because massive post-pneumonectomy bronchopleural fistula is rare, few surgeons have extensive experience in its management. The literature on bronchopleural fistula is large; however, few of these numerous reports have detailed the management of an acute post-pneumonectomy fistula. The timing of surgical intervention and the type of operative procedure advocated vary widely.\(^3,5,12\) During the decade 1965 - 1975, in a series of 100 consecutive pneumonectomies carried out at the New York University Medical Center, 2 massive bronchopleural fistulas occurred postoperatively; both patients were treated by early operative intervention, with closures of the fistula using intercostal muscle flaps. The repair attempts failed and both patients ultimately died. Analysis of these failures caused us to formulate a staged approach which was successfully employed in a subsequent patient. Prompt pleural drainage was initiated and the patient's clinical condition was stabilized. A group of operative procedures was then used in a sequence that ensured safety and minimal morbidity. Extensive reconstructive and plastic procedures were avoided. The purpose of this article is to detail this means of managing acute massive post-pneumonectomy bronchopleural fistula when there is no long bronchial stump remnant but rather a flush division of the tracheobronchial junction. Division and closure of the main bronchi within 1 cm

REFERENCES