Objective: To examine our outcomes with skin paddle survival using pectoralis myocutaneous flaps in reconstruction of the head and neck. The pectoralis major myocutaneous flap has been associated with a notable incidence of distal skin necrosis and flap loss. Our experience has been favorable compared with that reported in the literature.

Methods: Retrospective medical record review of 81 cases of pectoralis major muscle flap reconstruction performed in 78 patients from 1995 to 2008 using a flap harvest technique that is slightly different from the classic description. Data were obtained regarding coexisting health conditions and perioperative complications, which were divided into major and minor categories. Major complications were defined as total flap failure or greater than 25% skin paddle loss. Minor complications and donor site complications included fistulas that were managed conservatively, wound dehiscence not requiring additional surgery, local infections, seromas, and hematomas.

Results: Of the 81 flaps performed, 22 complications were encountered. Total flap loss was not encountered in any patient. The overall major complication rate in myocutaneous flaps was 3 of 76 (4%), with these cases consisting of significant skin paddle loss. Minor complications occurred in 14 of 81 myofascial and myocutaneous flaps (17%). Donor site complications of the chest wall occurred in 5 of 81 flaps (6%).

Conclusions: Skin paddle necrosis may be minimized with modifications of the classic technique. We believe that extension of the skin flap over the rectus sheath is the cause of distal skin flap necrosis. The pectoralis major myocutaneous flap remains a valuable reconstructive option in the head and neck.

Arch Facial Plast Surg. 2009;11(5):306-310

The pectoralis major myocutaneous (PMMC) flap has been considered the workhorse reconstructive flap for head and neck defects since its initial description in the late 1970s. Reliability, versatility, and ease of harvest have been the hallmarks of the PMMC flap. Established uses include esophageal luminal augmentation, reconstruction of oral cavity and oropharyngeal defects, lateral mandibular defects less than 5 cm in length, skull base and temporal bone defects, orbitomaxillary defects, and cutaneous defects of the cheek, neck, and chin.

The incidence of total flap necrosis has been reported to be between 1% and 7%. Partial necrosis has been reported at rates between 4% and 29%. Many factors have led to the increased popularity of free flap reconstruction for head and neck defects. Average flap survival with free tissue transfer has been reported to be 96.4%. Our experience with PMMC flap survival is similar to free tissue flap survival, suggesting that the PMMC flap still has a role in the reconstruction of appropriately suited defects or in patients in whom anatomic or systemic factors benefit from its advantages.

METHODS

DESIGN

A retrospective medical record review was performed on 81 consecutive cases of pectoralis muscle flap reconstruction in 78 patients from 1995 to 2008. All subjects were treated by the primary investigator (J.P.C.) at the University of Colorado–affiliated hospitals. The medical records were reviewed for coexisting health conditions, perioperative, and postoperative complications. Complications were broken down into major and minor categories. Major complications were defined as total flap failure or significant skin paddle loss (>25% surface area). Minor complications and donor site complications included fistulas managed conservatively, wound dehiscence not requiring additional surgery, local infections, seromas, and hematomas.
is made between the pedicle and the humeral attachments, which
vacular attachments to the clavicle. A similar lateral series of passes
ning on the deep aspect of the pectoralis major muscle. The lat-
or minor is defined and bluntly dissected. The pectoral
plane between the pectoralis major muscle. The lat-
are also taken down with electrocautery. The lateral thoracic ar-
ory contributions, as well as the medial and lateral pectoral nerves,
division was divided in all cases. Subclavicular tunneling or clav-
are not used in our series. With the use of
these techniques, a reach as superior as the eustachian tube in
hyopharynx and the superior aspect of the helix for tem-
oral bone reconstructions is possible to achieve without ten-
Distal flap design over the rectus sheath is not needed to
ache these lengths. For defects lower in the neck, such as
opharyngeal or lower neck skin defects, the skin paddle may
be placed more proximal over the muscle. In these cases, the
position of the skin paddle may be judged based on the anti-
cated arc of rotation over the clavicle. In 3 patients in whom a
large skin paddle was harvested, primary closure of the donor
site was not feasible and skin grafting was performed.

SURGICAL TECHNIQUE

The anatomy of the PMMC flap is well described in the litera-
ture and is presented in Figure 1. A few modifications have
been made to the traditional surgical technique, and different
fundamental surgical decision making for men and women is
used. For men (Figure 2), our myocutaneous flap is gener-
ally designed with the skin paddle medial and inferior to the
ipple. The first line of our flap design (line A) is drawn from
the superior anterior axillary crease, medial to the nipple, down
to the upper rectus sheath. Medial to this line, we outline the
anticipated skin paddle. The first incision is made laterally, fol-
lowing line A, and carried down to the superficial fascia of the
pectoralis major muscle. The inferior border of the pectoralis
major muscle is identified. The proposed position of the skin
paddle is then adjusted accordingly so that it overlies muscle
in its entirety. If it was initially drawn too superiorly, the paddle
is adjusted distally; conversely, if it was initially drawn over
the rectus sheath, the skin paddle is moved more proximally.
The second line (line B) is drawn medial to the first, incorpo-
rating the skin paddle in a large curvilinear fashion (Figure 3).
This allows for primary closure of a large, curved elliptical de-
fect in most cases. The medial skin incision is made and taken
down to pectoralis muscle fascia. Interrupted silk sutures are
placed between the muscle fascia and the dermis to prevent the
skin paddle shearing from the muscle during dissection. Elec-
trocautery may be used for hemostasis away from the skin
paddle, but the cold knife technique is preferred for dissection
around the skin paddle. The plane between the pectoralis ma-
jor and minor is defined and bluntly dissected. The pectoral
branches of the thoracoacromial artery can be seen and felt run-
ning on the deep aspect of the pectoralis major muscle. The lat-
eral and inferior aspect of the pectoralis muscle is elevated off of
its rib attachments. The dissection is carried medially toward the
sternal attachments. A large clamp is then passed under the muscle
along the sternum, and electrocautery is used to divide and free
the muscle. This is taken all the way to the clavicle, where the
clamp may be reflected superiorly for definitive visualization of the
vascular pedicle. The clamp is passed along the clavicle medial
to the pedicle, and electrocautery is used to take down the mus-
cular attachments to the clavicle. A similar lateral series of passes
is made between the pedicle and the humeral attachments, which
are placed more proximal over the muscle. In these cases, the
position of the skin paddle may be judged based on the antici-
pated arc of rotation over the clavicle. In 3 patients in whom a
large skin paddle was harvested, primary closure of the donor
site was not feasible and skin grafting was performed.

Figure 1. Surgical anatomy of the pectoralis major myocutaneous flap.

Figure 2. Pectoralis major myocutaneous flap technique for male patients.
Line A represents the lateral incision, the first one made in the procedure. SP
represents the initial proposed skin paddle, whereas SP' represents the
better skin paddle location entirely overlying the pectoralis muscle.

Figure 3. Pectoralis major myocutaneous flap technique for male patients.
Line A represents the lateral incision. SP' represents the final position of the
skin paddle. Line B demonstrates the medial curvilinear incision, which aids
in closure of the donor site.
For women, experience has led us to follow 2 separate strategies based on breast size. The first strategy is for women with smaller breasts (Figure 4). It is our opinion that it is safe to use an inframammary skin paddle in this instance. The breast is retracted superiorly. The planned skin paddle is designed slightly superior to the inframammary crease. The initial incision is started in the mid-axillary fossa and extended inferiorly along the lateral aspect of the breast and pectoralis muscle. The pectoralis muscle is identified and followed inferiorty and medially. Great care is taken to assure that the skin paddle is completely over the muscle; if it is not, the skin paddle is redesigned more superiorly prior to incision of the inframammary skin paddle itself.

For women with medium and larger breasts, natural breast ptosis can shift the inframammary crease inferiorly, off of the pectoralis muscle bed onto the rectus sheath. Excessive retraction of the breast superiorly during skin paddle design may malposition the cutaneous portion of the flap, creating the illusion that the skin paddle is positioned over the muscle. This should be avoided. In attempts to use cosmetically acceptable inframammary skin paddles in women with large breasts, we encountered vascular insufficiency in both cases intraoperatively, and the skin paddles were not viable. Although more disfiguring, we recommend designing the skin paddle for larger breasted women similar to the way done in men. However, the flap is designed inferiorly in the area of less subcutaneous breast tissue to decrease the distance between the skin and the muscle, still taking care to keep the entire skin paddle over muscle. Breast size is a subjective clinical assessment. When in doubt, we prefer to err on the side of caution and avoid the inframammary skin paddle.

We start the incision for flap harvest at the anterior axillary crease, rather than along the clavicle, to preserve the availability of the deltopectoral flap for later use. A second incision may be made horizontally along the clavicle, if necessary for visualization. This clavicular incision also helps “delay” a future deltopectoral flap, if needed. A generous tunnel over the clavicle is used, usually large enough to admit the surgeon’s entire hand. One may thin out the muscle around the blood vessels very aggressively, which can aid in flap rotation. Use of bipolar cautery or surgical clips is recommended when close to the pedicle. The medial and lateral pectoral nerves are taken down to allow for adequate rotation. These nerves can cause vascular occlusion of the pectoral vessels when the flap requires rotation to fill a cutaneous defect. A branch of the lateral thoracic artery is sometimes seen and confused for the pectoral branch of the thoracoacromial artery. This artery should be maintained until the correct branch is identified medially. If a tracheotomy is used for the case, it must be sutured into position. Tracheotomy ties can lead to vascular compression and flap loss.

Table 1. Major Complications, Minor Complications in the Head and Neck, and Donor Site Complications

<table>
<thead>
<tr>
<th>Case Description</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major complications</td>
<td></td>
</tr>
<tr>
<td>Significant cutaneous loss</td>
<td>2</td>
</tr>
<tr>
<td>Discarded skin paddle without negative case outcome</td>
<td>1</td>
</tr>
<tr>
<td>Major complications, No./total No.</td>
<td>3/76</td>
</tr>
<tr>
<td>Major complication rate, %</td>
<td>4</td>
</tr>
<tr>
<td>Minor complications in the head and neck</td>
<td></td>
</tr>
<tr>
<td>Skin paddle dehiscence, treated conservatively, No.</td>
<td>6</td>
</tr>
<tr>
<td>Fistula, treated conservatively, No.</td>
<td>3</td>
</tr>
<tr>
<td>Seroma, No.</td>
<td>3</td>
</tr>
<tr>
<td>Infection requiring hyperbaric oxygen therapy, No.</td>
<td>1</td>
</tr>
<tr>
<td>Hardware removal and eventual free flap reconstruction for mandibular continuity, No.</td>
<td>1</td>
</tr>
<tr>
<td>Infection treated by incision and drainage, No.</td>
<td>1</td>
</tr>
<tr>
<td>Minor complications, No./total No.</td>
<td>14/81</td>
</tr>
<tr>
<td>Minor complication rate, %</td>
<td>17</td>
</tr>
<tr>
<td>Donor site complications</td>
<td></td>
</tr>
<tr>
<td>Chest wall dehiscence, No.</td>
<td>1</td>
</tr>
<tr>
<td>Retained drain, No.</td>
<td>1</td>
</tr>
<tr>
<td>Chest wall infection, No.</td>
<td>1</td>
</tr>
<tr>
<td>Seroma, No.</td>
<td>1</td>
</tr>
<tr>
<td>Hematoma, No.</td>
<td>1</td>
</tr>
<tr>
<td>Donor site complication rate, No./total No.</td>
<td>5/81</td>
</tr>
<tr>
<td>Donor site complication rate, %</td>
<td>6</td>
</tr>
</tbody>
</table>

From 1995 to 2008, 81 pectoralis flap surgical procedures were performed in 78 patients (76 PMMC flaps and 5 pectoralis myofascial flaps). Of the 81 flaps, 9 were performed in 8 female patients. Of the PMMC flaps, 1 incorporated the fifth rib for a mandibular defect and 2 placed the skin paddle on the mucosal surface with a skin graft externally for through and through cheek defects. Of the 5 myofascial flaps, 3 were skin grafted and 2 were used as a muscle only flap. Of the 81 flaps performed, 22 complications were encountered. Total flap loss was not encountered in any patient.

Of the 76 PMMC flaps, we encountered 3 significant skin paddle losses which we deemed “major complications” (4%) (Table 1). These cases will be discussed in detail later. Minor complications in the head and neck occurred in 14 of 81 patients (17%), and are also outlined in Table 1. All were managed conservatively except for a postoperative neck wound infection, which required hardware removal. There were 6 wound margins that partially dehisced (neck and oral cavity) and healed with conservative treatment. There were 3 fistulas that...
Replanted with conservative management. Three seromas and 1 neck infection required drainage performed in clinic. Donor site complications of the chest wall occurred in 5 of 81 patients (6%) (Table 1). There was a patient with a retained drain that required return to the operating room. A chest wall dehiscence in a malnourished patient was managed conservatively. A chest wall infection, seroma, and hematoma were all treated with in-office procedures.

**COMMENT**

The pectoralis major muscle is supplied by the pectoral branches of the thoracolumbar artery. Traditional descriptions of the pectoralis flap describe that the xiphoidomeral line is defined and a vertical perpendicular line is then dropped from the midpoint of the clavicle to help find the pectoral branch of the thoracolumbar trunk. The skin paddle position was determined based on this estimated pedicle location and the anticipated arc of rotation with relationship to the clavicle. Occasionally, the skin paddle ends up at the caudal most aspect of the pectoral muscle, extending onto the superior rectus sheath. It has been our opinion that extension of the flap onto the rectus sheath leads to the frequent distal skin necrosis that is reported. Multiple anatomic vascular studies have defined this distal skin area to have a random blood supply, and several prior studies have hinted that the inclusion of this area into the skin paddle may be a cause of partial skin paddle necrosis. It is this difference in blood supply that distinguishes the distal skin paddle vascularity from the reliable blood supply to the myofascial portion of the flap.

Definitions of total flap loss vary, making comparisons with previous reports difficult. Some articles describe the loss of the skin paddle as total loss, while others describe it as total loss of muscle and skin. Previous reports have described major flap necrosis in the 1% to 7% range and partial skin flap necrosis in the 4.0% to 29.0% range. This wide range may be a result of surgical technique, patient population, and the type of defect reconstructed. In our cohort, we had a 4% rate of major skin paddle loss and no total myofascial or myocutaneous loss. We did not encounter any minor skin paddle necrosis. The types of defects reconstructed are listed in Table 2.

We do not use the classic operative technique. We attribute our favorable skin paddle survival to the skin paddle position adjustment to a location entirely over muscle. The senior author (J.P.C.) began to use this technique based on the simple clinical impression that keeping the skin over the muscle incorporated more cutaneous perforators, which has been demonstrated in anatomic studies. By following the surgical techniques outlined in the “Methods” section, we incorporate the first- and second-level angiosomes at the distal aspect of the muscle and exclude the unfavorable, third-level angiosome over the rectus sheath. In addition, most of our skin paddles incorporate the relatively large perforating branch from the fourth intercostal space, which is described as being approximately 2 cm medial to the nipple.

Two of our significant flap losses occurred in patients with serious comorbidities. The first patient had failure of a previous fibular free flap reconstruction and had a prolonged and complicated hospitalization prior to PMMC flap reconstruction. At the time of surgery, she was severely hypoalbuminemic (albumin level, 1.0 g/dL [to convert to grams per liter, multiply by 10]). She also had a previous lumpectomy and had undergone radiation therapy for breast cancer on the affected side. The initial inframammary skin paddle quickly appeared congested and discolored, with hypoxic, purple blood oozing from the wound edges. We thought it was nonviable and discarded this first skin paddle. We then moved superiorly and medially on the breast to harvest a second skin paddle in a more favorable anatomic location. While harvesting the second paddle, we entered into her 5 × 5 × 7-cm fluid-filled lumpectomy cavity medial to the skin paddle. This did not seem to affect the skin negatively, and it was used to reconstruct her ipsilateral tongue and floor of mouth defect. The patient formed a fistula, lost 80% of the skin paddle, and eventually healed without further surgery. Harvesting a flap from a radiated, previously operated breast was risky, but with her poor nutritional state, we thought that another microvascular free flap would have been riskier. She was overweight with ptotic breasts, making the inframammary crease incision unfavorable. Later, after the patient was nutritionally replete, a second pectoralis flap was performed on the other side. The skin medial to the nipple was brought up with the fifth rib to reconstruct the mandible and performed well.

The second patient was a smoker with systemic lupus erythematosus, coagulopathy, severe Raynaud syndrome with autoamputation of his fingers and ears, and a history of radiation therapy to his face. A radial forearm free flap would have been ideal for a chin and lip defect, but concerns over flap and limb loss in a patient with Raynaud syndrome led us away from free flap options and toward PMMC reconstruction. Every incision we made in the face, neck, and chest exhibited wound edge breakdown postoperatively. We subsequently lost approximately 50% of the skin paddle over his mentum. These wounds healed with hyperbaric oxygen and conservative management. We believe that this was the right treatment decision for this patient and that his skin paddle was designed appropriately and the partial loss was due to his comorbidities, not poor flap design or surgical technique.

The third nonviable skin paddle was in a large-breasted, obese woman with recurrent cervical metastas-
ses involving the skin. We needed muscle for carotid artery coverage and skin to be used externally for the cutaneous defect. We created an inframammary skin paddle that was clearly ecchymotic and oozing purple blood intraoperatively. The skin paddle was obviously not viable and therefore discarded. The ptotic breast placed our skin paddle too low over the rectus sheath beyond the second-level angiosome. A muscle-only flap was used with a skin graft externally. She had an excellent outcome. In retrospect, a skin paddle medial to the nipple should have been used in a woman of this size. Despite her good outcome, we consider this a complication that could have been avoided with better skin paddle design.

In conclusion, it is our impression that the pectoralis myocutaneous flap remains a valuable reconstructive option in the head and neck. By following the anatomic principles outlined herein, success may be maximized. Essentially, if the skin paddle is kept over the body of the muscle, skin paddle loss is rare. Extending the flap over the rectus sheath is likely the cause of distal skin flap necrosis and may not be necessary if other technical nuances are used to aid in flap rotation. Although our number of female patients is small, our clinical experience may be useful. In small-breasted women, an inframammary incision is reasonable, but for larger or ptotic breasts the technique similar to that used in men is more appropriate. When correctly performed, myofascial flap survival is virtually guaranteed; however, it must be remembered that the ultimate success of the skin paddle is likely a function of both technical considerations and unique patient factors.

Accepted for Publication: February 20, 2009.
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Financial Disclosure: None reported.
Previous Presentation: This study was presented at the American Academy of Facial Plastic and Reconstructive Surgery annual meeting: September 20, 2008; Chicago, Illinois.

REFERENCES