The Omentum

Its Use as a Free Vascularized Graft for Reconstruction of the Head and Neck

M. J. JURKIEWICZ, M.D., FOAD NAHAI, M.D.

The experience at Emory University Affiliated Hospitals with transplantation of the greater omentum as a free revascularized graft in 18 patients is presented. In each instance, there was realization of the therapeutic objective, either 1) the amelioration of congenital or acquired somatic deformity (14 patients) or 2) the control of infection (4 patients). Because the omentum is a syncytium of blood vessels and a variable amount of fat within redundant leaves of peritoneal membrane laden with macrophages, it is a tissue that serves admirably its extended role as an extracelomic free transplant. The greater omentum has been used for this purpose in five patients with hemifacial atrophy (Romberg's disease); three patients with hemifacial microsomia (first and second branchial arch syndrome); two patients with extensive losses of the maxilla, palate, and face due to a shotgun blast; two patients with atrophy and facial growth arrest due to x-irradiation; and two patients with deformity of the jaw and neck following tumor resection. In three additional patients, the omentum was used to obliterate the dead space after debridement of an infected open frontal sinus following failure of conventional therapy. In one instance, a revascularized free graft of omentum was used to salvage a patient with an exposed irradiated carotid artery graft and skin flap failure following radical neck dissection. In these 18 patients, there were no intra-abdominal complications consequent to harvest of the omentum. In one patient afflicted with hemifacial atrophy, there was spotty necrosis of the overlying attenuated facial skin flap and limited fat necrosis. In the follow-up period of four months to seven years, there has been no instance of late resorption. The method is reliable and has considerable promise in reconstructive surgery.

From the Joseph B. Whitehead Department of Surgery, Division of Plastic, Reconstructive and Maxillofacial Surgery, Emory University School of Medicine, Atlanta, Georgia

THE PROGRESS that has been made in microvascular surgery attendant upon better instrumentation, refined techniques, and improved knowledge of anatomy is nothing short of remarkable. Replantation of amputated parts is commonplace and predictable: heterotopic transfer of composite tissue as a revascularized free graft can be accomplished with a confidence rate of better than 95%. Thus, in certain clinical problems involving primarily soft tissue loss, replacement by a free omental graft is, in the opinion of the authors, the procedure of choice. Three generic uses for such a free transfer have evolved in the practice at this institution: contour, control of wound infection, and provision of blood supply for free grafts of ribs and skin. When the deformity involves primarily the loss of subcutaneous fat or other soft tissues, an omental free graft serves admirably. Hemifacial atrophy, hemifacial microsomia, growth failure, or atrophy secondary to x-irradiation are clinical conditions in which free omental transfer has been extremely useful.

In its orthoptic position, the omentum is, in fact, peritoneal membrane. As such, it participates actively in the function of the peritoneum, a membrane of considerable surface area, freely permeable not only to water and electrolytes, but also to endogenous and exogenous toxins, primarily bacterial toxins. Redundant as it is, the omentum has, as its principal function, localization of an inflammatory process.[9] The omentum and bowel surrounding an irritant quickly adhere to an inflamed area by sticky fibrinous exudate.

Macrophages, present both as scattered cells or in aggregates called "milky spots" throughout the omentum, suggest an efficient mechanism whereby the omentum is effective against bacteria.[4] It seems reasonable, therefore, that in a heterotopic location the omentum could continue its peritoneal role and thus be useful not only in the treatment of cavitational wounds, chronically infected, but also of broken-down irradiated

Presented at the Annual Meeting of the Southern Surgical Association, December 7–9, 1981, Hot Springs, Virginia.

Reprint requests: M. J. Jurkiewicz, M.D., Division of Plastic Surgery, 25 Prescott Street, N.E., Atlanta, GA 30308.

Submitted for publication: January 11, 1982.

0003-4932/82/0600/0756 $01.00 © J. B. Lippincott Company

wounds colonized by opportunisitc bacteria. Use of the omentum as a free revascularized graft to obliterate the dead space following debridement of chronic frontal sinus osteomyelitis was followed by prompt cure in three patients.

Shotgun wounds of the face, often self-inflicted, characteristically destroy portions of palate, maxilla, and orbit. Reconstruction is often complex and multistaged, and involves considerable bone carpentry. Split ribs make a reasonable facsimile of the maxilla, palate, and orbital floor but need to be covered and nourished in order to "take." Omentum in such a role serves well.

Use of the greater omentum, as a free graft revascularized by microsurgical techniques in a heterotopic head and neck site in 18 patients, is described.

Clinical Material

The omentum has been used as an extracelomic transposition flap in 22 patients with defects of the chest wall as a result of extirpation of tumor or osteoradionecrosis, or as an adjunctive measure in the treatment of open infected median sternotomy wounds.[2,6,7] In 21 patients, a portion of the greater omentum has been used as a free graft revascularized in a heterotopic site, for a total use of the greater omentum for reconstructive purposes in 43 patients. The experience in 18 patients in whom such a free revascularized graft was used in the head and neck area form the basis for this article (Tables 1 and 2).

The first of these patients was a 48-year-old man who had had multiple operations during the preceding two years in other hospitals. Depressed, he had attempted to end his life using a shotgun. The blast had taken out essentially the central portion of his face, sparing the right eye. A chest flap had been used to restore a portion of his mouth, including sealing of a huge opening that communicated with both atra and the nasal cavities. The external nose had been reconstructed by an arm flap. Each of these flaps lacked support, and, thus, the face was totally flat. Several attempts at bone grafting had failed. It was reasoned that failure of free bone grafts had been due to several factors: poor blood supply available in the skin flaps, insufficient cover or lining, or a persistant communication with the lining of the antrum or nose. Split-rib grafts were placed across the maxilla and were used to provide a nasal skeleton. The previously placed skin flaps were used for cover, while a free graft of greater omentum revascularized to the facial vessels was used to obliterate the antrum and nose and to provide the requisite blood supply for take of the rib grafts. Skin grafts over tubes were used to provide a nasal airway. A much improved contour was achieved with a successful take of the bone grafts. The nasal airway remained a problem because of stenosis of the circular skin grafts.

TABLE 1. *Number of Cases*

Hemifacial atrophy	5
Hemifacial microsomia	3
Traumatic defects	2
Facial growth arrest	2
Tumor resection	1
Control of infection	3
Exposed carotid artery	1
Neck reconstruction	1
Total	18

The second patient was a young woman injured by a shotgun blast at short range. Much of the maxilla, left side of the face, nose, and orbit was lost in the incident. She had been resuscitated at another hospital and was transferred two weeks after injury, wired, and infected. After thorough debridement, the maxilla, nose, orbit, and cheek were rebuilt in one stage by using free split-rib grafts as a scaffolding for the palate, floor of the nose, maxilla, and orbit. These grafts were then totally covered by a free omental graft revascularized to the facial vessels.

Skin grafts were used to provide cover for the cheek, mouth, and left side of her nose. The subsequent postoperative course was uneventful. A healed wound, including take of the entire free rib neomaxilla and orbit, was achieved.[3] She subsequently has had several procedures to correct enophthalmos and the problems attendant upon missing facial nerve and paralysis on the left side.

Twelve patients have been treated for loss of soft tissue substance in the face or neck. In this group were five young adults stricken by Romberg's disease, an idiopathic, progressive hemifacial atrophy that involves not only subcutaneous fat but also skin, muscle, bone, and cartilage (Fig. 1). An additional three had congenital hemifacial microsomia, wherein variable degrees of growth arrest occurs in the mandible, maxilla, and ear (Fig. 2). The parotoid gland, as well as the masseter muscle, may be very small or missing on the affected side. In these three patients, the skeletal growth disturbance had been ameliorated by orthodontic means, and the residual deformity was primarily soft tissue in

TABLE 2. *Subjective Evaluation (1 = Poor, 5 = Exceptional)*

Hemifacial atrophy	4.0
Hemifacial microsomia	4.0
Traumatic defects	1.5
Facial growth arrest	4.0
Tumor resection	3.0
Control of infection	5.0
Exposed carotid	5.0
Neck reconstruction	4.0

FIG. 1a. Correction of hemifacial atrophy. Young man with hemifacial atrophy involving left half of face and temple.

nature, thus amenable to correction by a free omental graft.

Of the remaining four patients in the group, two had deformities secondary to tumor removal—one for osteosarcoma of the jaw and the other secondary to standard radical neck dissection many years previously for papillary carcinoma of the thyroid. The remaining two patients in the group had growth arrest secondary to radiation for malignant tumor in childhood.

In the final four patients, control of infection and cover for an exposed irradiated carotid artery in the neck were the indications for use of omentum. Three patients had open, infected, draining frontal sinus. In two, this was secondary to failure of conventional treatment of an open fracture by reduction, stripping of mucosa, and packing the sinus with a free fat graft. The other patient had a chronic osteomyelitis of both frontal sinuses, with an open draining cutaneous fistula secondary to a combined intracranial and extracranial approach to an orbital, ethmoid exenteration for an adenocarcinoma of a nasal turbinate. In these three patients, the sequestered and infected bone was thoroughly debrided and curetted. The resultant cavity was then obliterated by a free graft of omentum revascularized to the superficial temporal vessels, with control of the acute and chronic osteomyelitis in each instance (Fig. 3).

The final patient in this group was operated on for a postsurgical recurrent epidemoid carcinoma of the mouth with failure at the primary site and in the neck. Resection involved not only the jaw, but also skin overlying the jaw and also in the neck—adherent as it was to metastatic disease. In the resection, it was necessary to take a portion of the common carotid artery. This was replaced by an alloplastic graft, covered by skin flaps advanced over the graft. When flap failure occurred, the patient was salvaged by a free omental graft, split-skin grafts, and a subsequent chest flap.

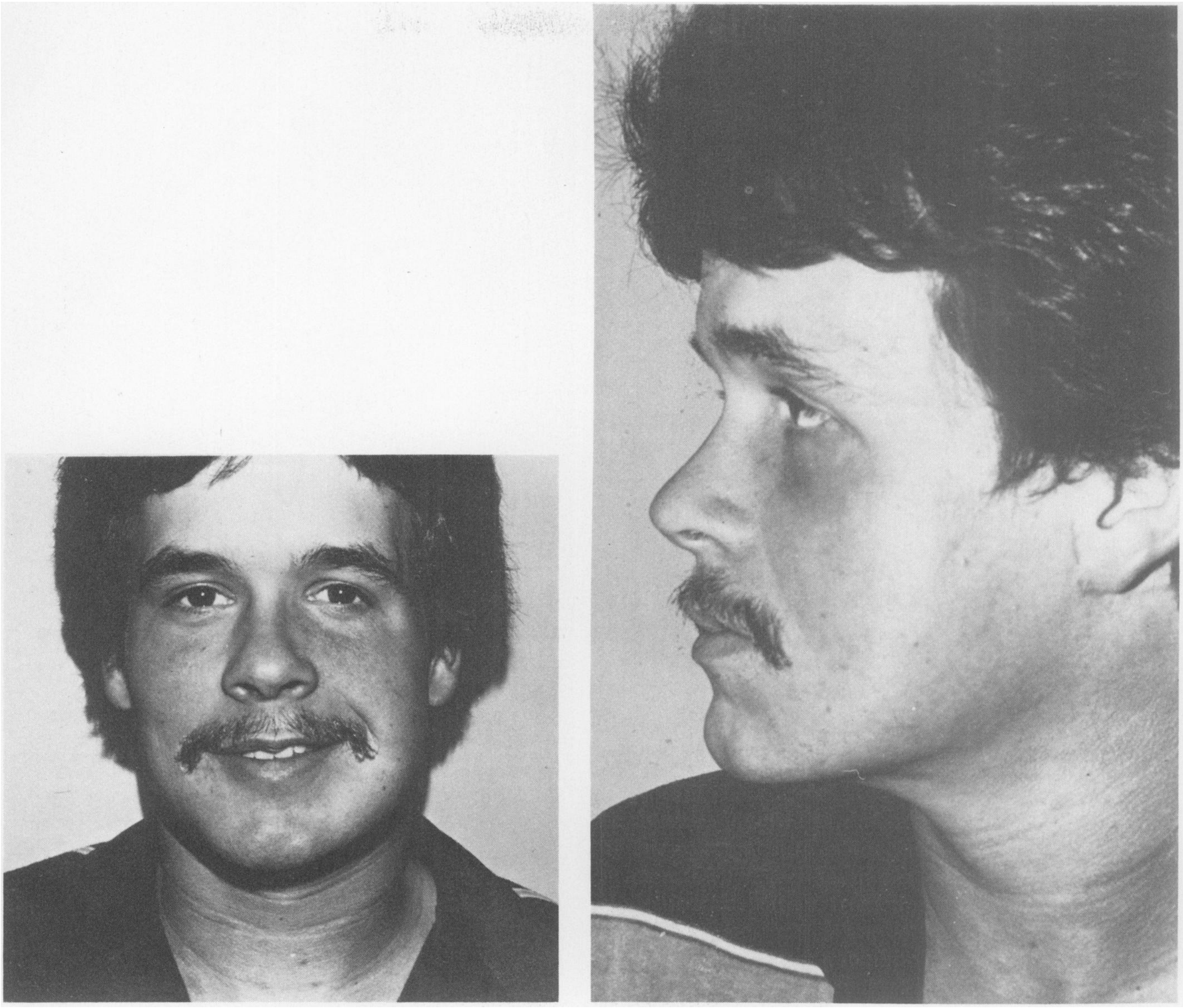

FIG. 1b. Correction of hemifacial atrophy. Postoperative result at three years, following a second procedure to revise and thin the transferred omentum.

Operative Technique

Preoperative Preparation

The day prior to operation, there is a mechanical preparation of the bowel, and the patient is placed on a clear liquid diet. The abdomen, face, and neck are washed with hexachlorophene soap the night before operation.

A broad-spectrum antibiotic or an antibiotic appropriate to the microbial flora of the open wound is started parenterally the night before operation or one hour before operation.

General Operative Procedure

Following the induction of general endotracheal anesthesia, the endotracheal tube is secured. The preferred method at this institution is to wire the tube to one of the premolar teeth. A nasogastric tube is then passed to decompress the stomach. The head and neck and abdomen are prepared widely and draped separately. Exploration and preparation of the face and neck, and celiotomy to harvest the omentum then proceed simultaneously with two teams of surgeons, two scrub technicians, and two separate instrument setups.

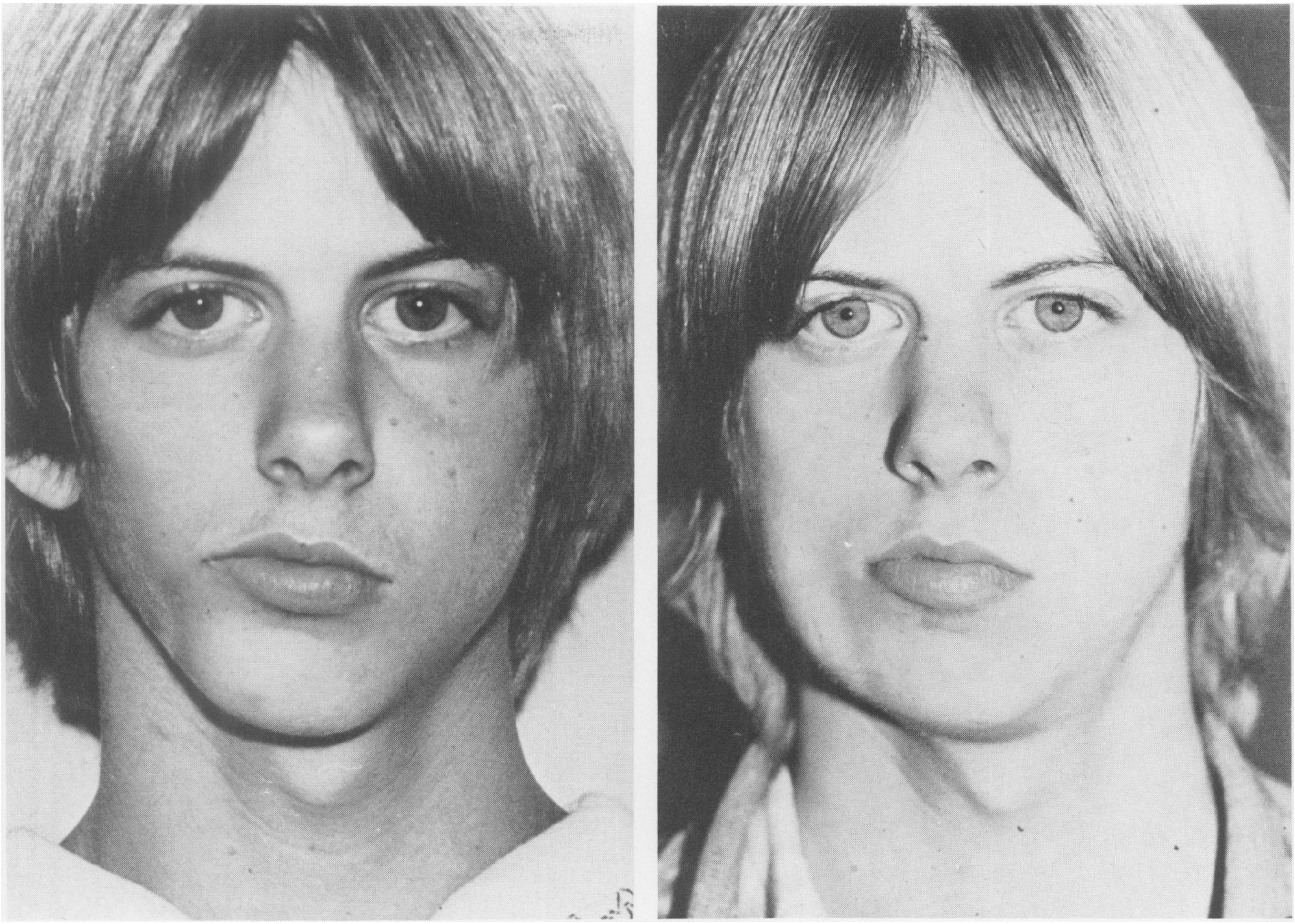

FIG. 2. Correction of hemifacial microsomia. Left, 12-year-old boy with right-sided hemifacial microsomia. Right, postoperative result at one year.

Head and Neck Exploration and Preparation

An incision appropriate to isolate the vessels suitable for the microvascular anastomosis is made. In general, an incision similar to that commonly done for parotidectomy is preferred, but with extension into the temporal scalp around the ear, across the mastoid tip, and then within the hairline of the neck. A skin flap is raised to the limits of the defect at the subcutaneous level to gain appropriate exposure not only to the defect, but also to the facial nerve and to the vessels in the neck.

In each instance possible, the superficial temporal artery or facial artery and posterior facial vein are used as the recipient vessels. The superficial temporal is the preferred vessel for the face. Above the level of the zygomatic arch, the artery is too small for predictable success. Accordingly, the approach is to isolate the main trunk of the facial nerve, after the manner of Beahrs,[1] using the external auditory canal and the mastiod as guides. The terminal portion of the external carotid artery before it bifurcates into the superficial temporal and internal maxillary branches lies below the facial nerve. If the superficial temporal vessel is large enough, it is isolated, and transected between clamps, with an Ackland microvascular clamp used proximally. If the vessel is dissected back to the internal maxillary branch, a good length of vessel is available for comfortable anastomosis. Two and one half power loupes facilitate the dissection.

If the superficial temporal is too small, the vessel is harvested just below the main trunk of the facial nerve. It is mandatory that at least 2 cm of length be provided so that the microvascular anastomosis can be performed at a relatively superficial level rather than deep within the wound.

Only if the defect is in the neck, or if suitable vessels cannot be found just above or below the facial nerve, are the branches of the carotid in the neck used. Al-

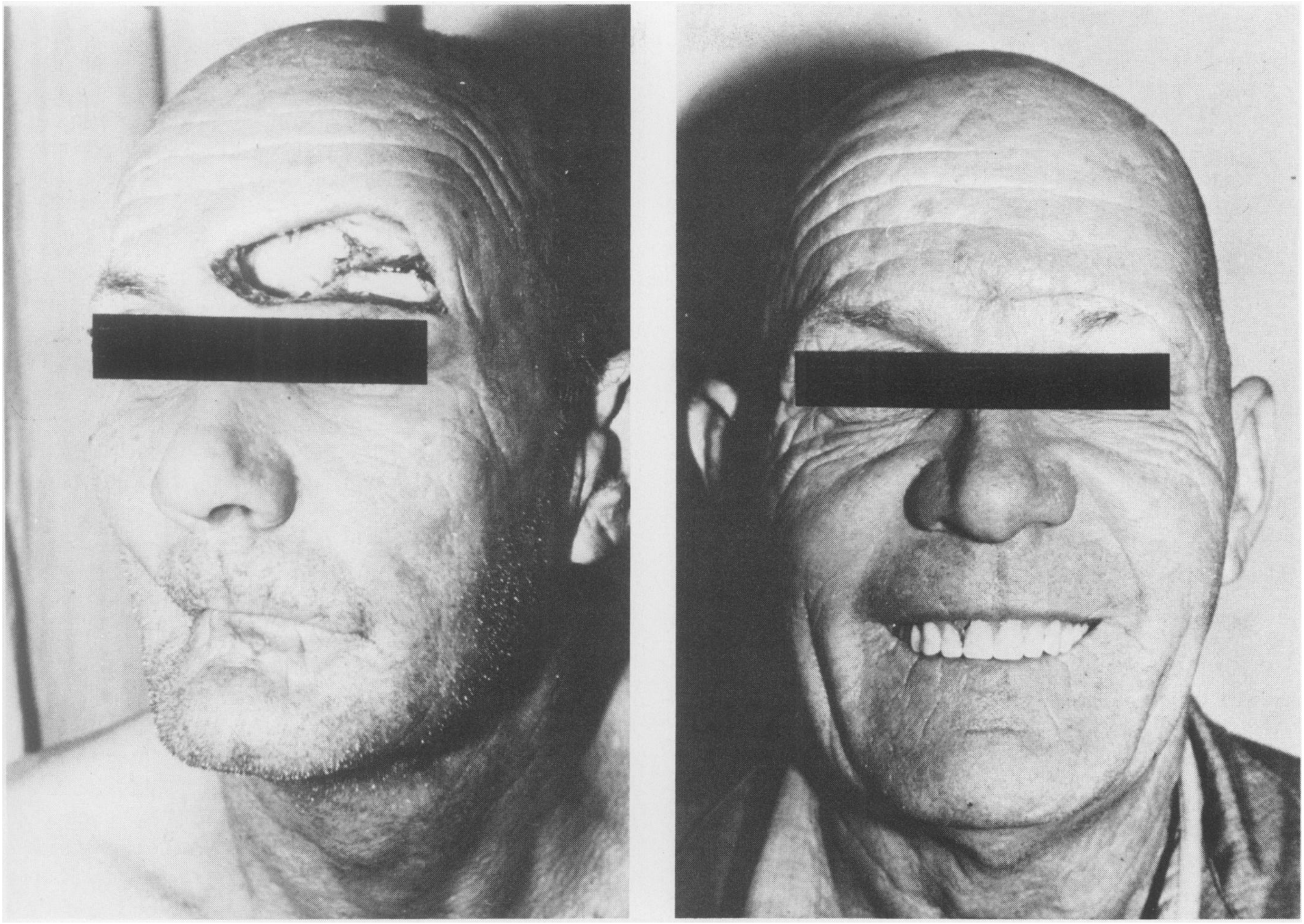

FIG. 3. Obliteration of infected frontal sinus. Left, open infected fracture of frontal sinus that has not responded to traditional methods. Right, one year postoperative infection resolved, and soft tissue contour restored.

though dissection here is much easier, the pedicle of the omentum with its surrounding fat will make a bulge at the angle of the jaw. On the other hand, an anastomosis to the external carotid just above or below the facial nerve is unobtrusive. If ribs are to be removed to construct the maxillary skeleton, they are harvested first.

Abdominal Procedure

Simultaneous with exploration of the head and neck, a midline or transverse celiotomy is made, and an abdominal exploration is performed. The omentum is first separated from the transverse colon. The filmy nonvascular attachments are easily divided in a dissection that proceeds from left to right. The omentum is carefully separated from the transverse mesocolon. In some patients, the distinction between the transverse mesocolon and the omentum is not clear at this level. Once the greater omentum has been freed from the transverse colon and its mesentery, a decision as to whether to base the omentum flap on the right or left gastroepiploic vessels is made.

The right vessels are preferred since they are larger, and dissection is avoided in the area of the spleen. The omentum is then divided from the peripheral margin toward the gastroepiploic arcade at a point that would leave a suitable volume based on the right gastroepiploic vessels. The short gastric vessels are isolated, clamped, divided, and ligated. After each vessel is clamped, it is immediately ligated. Electrocautery is not used at any time during this procedure.

The rest of the omental dissection is performed under 2½-power loupe magnification. The short gastric vessels (branches of the gastroepiploic arcade to the greater curvature of the stomach) are isolated, clamped, cut, and ligated. This dissection proceeds along the greater curvature of the stomach to the pylorus. The right gastroepiploic vessels are isolated, the fatty tissue is dissected from the vessels, and the artery and vein are separated. A solution of xylocaine 1% and papaverene is dripped onto the vessels to prevent spasm. Dissection then continues toward the gastroduodenal artery. A vascular pedicle 6 to 10 cm is thus developed. The vessel lumen diameter is 1½ to 2 mm.

The abdominal wall sutures are then placed through the midline fascia but not tied. When the recipient vessels in the neck have been prepared, the right gastroepiploic artery and vein are clamped and cut, and the omentum removed from the peritoneal cavity. The vessels are tied, and preplaced abdominal wall sutures are then also tied. The subcutaneous tissue and abdominal skin are then closed by one team, while the other team proceeds with the microsurgical transfer.

Microsurgical Procedure

Once suitable recipient vessels in the neck have been isolated, the microscope is brought into the field.

The open proximal vessel ends held secure by Ackland clamps are irrigated with heparin solution. The adventitia is excised, and the vessel ends are ready for microanastomosis. At this stage, with suitable recipient vessels prepared, the right gastroepiploic vessels are clamped and cut, and the omentum is transferred to the neck. The omentum is temporarily sutured in place and covered with a moist sponge. The gastroepiploic vessels are irrigated with heparinized saline and the adventitia excised from the vessel ends. The artery and vein are then placed in microvascular approximating clamps, and under microscopic magnification an end-to-end anastomosis is made using interrupted sutures of 10-0 Prolene on a BV 6 needle. If an end-to-side arterial anastomosis is planned, the arterial anastomosis is made first. A 4-5 cm length of the recipient vessel is isolated and clamped with microvascular clamps. A small segment of the lateral wall of the vessel is excised (1.5-2 mm in diameter), and the gastroepiploic artery is sutured end-to-side.

When the vascular anastomoses are completed, the microvascular clamps are removed. There should be immediate flow into the omentum with a visible pulse in the gastroepiploic artery. At this point, the patient is given 1 g of Solumedrol® IV and 30 cc of dextran 40. The dextran is then continued after operation, 15-30 cc an hour for five days.

Trimming and Inserting of the Flap

It is usually preferable to have the surgeon not responsible for the microvascular anastomosis do the trimming and insertion of the flap. The microsurgeon is quite reluctant to trim any of the omentum. Because no resorption occurs, it is necessary to trim all excess and use only that amount necessary for the task at hand.

Because of the vascular anatomy of the omentum, it is possible to isolate multiple small flaps or fingers within the major omental graft to restore contour in the forehead, eyelids, cheek, and lips. Skin flaps can be dissected out to the midline if necessary, and each of these fingers sutured to skin with the tie placed over a small bolus of xeroform gauze. A useful technique is to use a straight needle held in a standard needle holder but with the tip protected by an Adson clamp. In this way, the needle can be brought to the precise area of skin to be penetrated. The protecting Adson clamp is removed, and the straight needle is driven through the skin. The remaining end of the suture is similarily driven through the omentum and skin, and, thus, a horizontal mattress suture is fashioned to be tied over a bolus. The wound is then thoroughly irrigated and tacked closed with a few sutures or staples to check for symmetry with the opposite side. Appropriate adjustments are made, and the wound is closed without suction drainage. If the skin is taut, it is preferable to vent it, and if the vent is large, to close the residual wound with a split-skin graft that can be resected later as a secondary procedure. Too much omentum in a tightly closed wound can lead to failure when obligatory wound edema ensues, hence a loose closure and the use of Solumedrol.

A compression dressing of modest proportions with access to the area of the pedicle for appropriate monitoring is generally used. The nasogastric tube is usually removed within 48 hours and a full liquid diet begun. Antibiotics are continued for three days after operation and dextran 40 for five days.

Discussion

There are three principal uses for the omentum in reconstruction at an extracelomic location. One is to provide contour when there has been loss of soft tissue; another is to provide a means to fill a cavitary wound, thus mounting an appropriate defense against infection; and the third is to provide vascular support for grafts of bone and skin or the implantation of alloplastic materials—prolene mesh in chest wall reconstruction for example.

Grafting of the omentum is not a new idea. Surgeons long have noted the ability of omentum to localize inflammation and wall off infection, and have used it as intra-abdominal flap over an intestinal anastomosis, as a patch over a sutured perforated duodenum, or in a Fredet-Ramstedt procedure. Kiricuta was the first to use the omentum as a flap to reinforce ureteral anastomosis and to repair vesical fistulae and defects of the pleura, bronchi, and chest wall.[8] Goldsmith suggested its use as an extracelomic transposition flap for palliation of lymphedema.[5] Initial enthusiasm has waned due to equivocal results of the procedure. The initial experience at this institution paralleled that of Kiricuta and Goldsmith, *i.e.*, the use of omentum as an extracelomic flap for lymphedema and reconstruction of the breast or chest wall.[6]

The first free flap of omentum was used by McClean and Buncke to cover a large scalp defect.[10] At this institution, the first free flaps of omentum were used to revascularize the ribs used as scaffolding to rebuild the maxilla in two patients in 1974 and 1975 with losses of structure attendant upon shotgun wounds.[3] The ribs were appropriately split and wired into position, with these free grafts briding defects in the maxilla and palate; they were then covered or wrapped with the free revascularized omental graft.

Appropriate overgrafting by split skin was then accomplished for cover. Omental grafts so placed serve admirably in providing the appropriate bed for the take of the bone grafts. There are, however, problems with gravitational forces on the very pliable heterotopic omental grafts covered only by split-thickness skin grafts.

The great advantage in using omentum in facial reconstruction lies in its vascularity and pliability, and in the ability of the surgeon to fashion small fingers of omentum (Fig. 4) to insert into each area of the face that needs augmentation.[13,14] The omental vascular arcade is usually visible, and one can thus fashion flaps without compromising vascularity in any way. The volume of fat so transplanted will, of course, vary with the weight gain or loss of the patient. The restored facial contour, however, has remained congruent with the general appearance of the patient. No resorption of fat has occurred in these patients, in sharp contrast to results of free dermis fat transplants. Such free fat transplants have the obvious advantage of simplicity in harvest and transfer. They are, however, predictable only in the observation that resorption is universal and very often total. Thus, an initial good result will wane and wither, resulting in a condition not dissimilar to that for which the operation was done in the first place.

One possible exception to the rule is the transplantation of fat into the frontal sinus. According to Montgomery, frontal sinus obliteration using an adipose implant is "consistently complete and uncomplicated" in the cat. The data show, however, that as much as 70% of the implant was fibrous tissue in observations up to 12 months.[11] Nonetheless, this method has become the standard procedure for frontal sinus obliteration in patients. It is not universally successful, and failures do

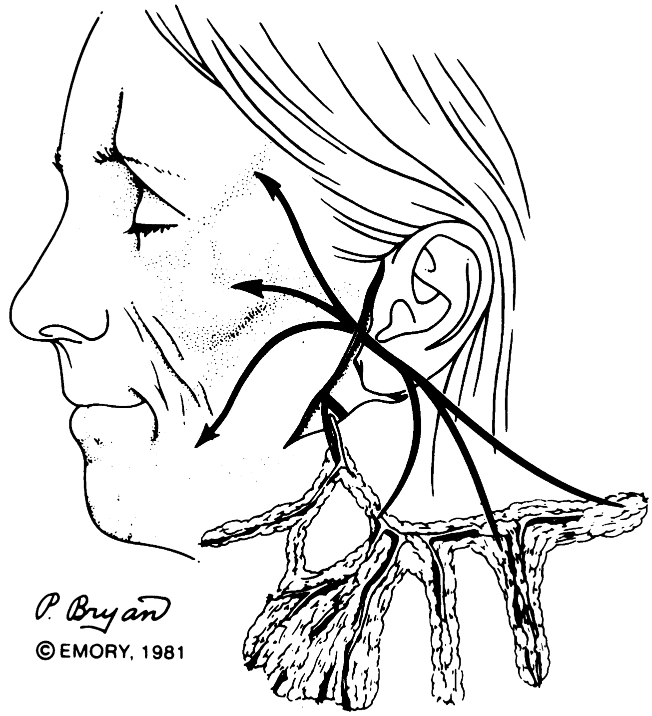

FIG. 4. "Mini" or "finger flaps" of omentum have been dissected and prepared for placement.

occur. Three such patients are included in this report. In these patients with chronic infection, repeat curettage and the transfer of a free adipose graft will have a very high failure rate. In the patients in the present series, however, a free transplant of omentum was successful not only in obliteration of the cavity and control of infection, but also in the restoration of normal contour. Although the number of patients is very small, the procedure does seem to merit consideration in salvage cases.

In theory, the omentum should bring to the heterotopic site those physiologic capabilities that have earned it the sobriquet "the abdominal policeman."[9] In essence, the omentum is a specialized form of peritoneum. As such, it participates in the general inflammatory response of the peritoneum in peritonitis. Although there has been some controversy as to its lymphatic supply, it has been unequivocally established that there are lymphatics accompanying the blood vessels.[12] Bacteria and carbon particles injected into the peritoneal cavity are removed by the omentum, as well as by lymphatics within the pelvis and diaphragm. The major reason, however, for its ability to cope with infection is probably directly related to the enormous numbers of macrophages within its areolar tissue.[4] Clearly, transposition flaps of omentum used to treat patients with osteo-radionecrosis of the chest wall and open infected median sternotomy wounds, and for free revascularized grafts have retained this physiologic function inherent in peritoneum.

Conclusions

The reconstruction of defects of the head and neck, particularly in patients afflicted with Romberg's disease (hemifacial atrophy), can be readily accomplished in reliable fashion by the use of an appropriate free graft of omentum revascularized in its recipient site. Moreover, the inherent capability of omentum to combat infection appears to be retained in such transfers. The intraluminal diameter of the gastroepiploic vessels and the rich vascular supply of the omentum not only permit reliable microvascular transfer but also provide an ideal bed for the take of bone grafts. The technique offers promise for reconstruction of the maxilla.

If a successful vascular anastomosis has been accomplished no resorption of the transferred omentum has occurred for as long as seven years. The technique is reliable and in selected patients promises a predictable method of reconstruction, particularly in the head and neck, where contour and symmetry are critical for an optimum result. Not only can facial contour be restored; enophthalmos can also be ameliorated. A revascularized graft of omentum is considered to be the procedure of choice for treatment of hemifacial atrophy.

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Discussion

[The discussion of Dr. P. G. Arnold is omitted at this point because, three weeks after his remarks were mailed to him, we had not received his edited discussion.]

DR. JOHN B. LYNCH (Nashville, Tennessee): I think since Dr. Jurkiewicz reported before this Association the use of omentum for chest wall defects as a transposition flap, and then in this paper reported on some of the unique advantages it has for reconstruction as a free transfer in selected head and neck cases, that they have made a real contribution.

Now, at Vanderbilt we've used the omentum for both of these indications, although admittedly in a much smaller group of patients than the Emory group. Despite the concomitant development of musculocutaneous flaps and a variety of free flaps, I do believe there are some defects that still lend themselves best to reconstruction with this type of use of the omentum.

Now, the author reports no intra-abdominal complications from harvesting the omentum. I will have to tell you that, although I agree that the morbidity is low, we do have one patient who developed a superficial abdominal wound infection, which responded well to simple local drainage.

Now, one question that I would like to pose is that we're always concerned when we think of omentum for reconstruction, and see scars on the abdomen, and get a history of previous surgery, as to whether or not the author has encountered any patient that he might consider omentum reconstruction the procedure of choice, and found the omentum not to be usable, by virtue of scarring, distortion, or other problems.

In head and neck reconstruction I will limit my comments primarily to contour problems, which is where we have had some experience. The authors point out the unique advantage of the omentum into little fingers, or pseudopods, and provide bulk for reconstruction of irregular defects.

This is a real advantage they don't emphasize, although they're aware of the opposite side of the coin. In thin patients, the omentum can make a very nice transfer for reconstruction of defects where bulk is undesirable. An example is a lady we treated this fall at Vanderbilt who had sustained extensive third degree burns of the face and entire scalp. The outer table of the skull had been removed; the skin grafts had been placed on the inner table. When she was referred to us, it was because of multiple areas of breakdown in the scalp scar, secondary to minor trauma.

In this patient no local flaps were available. The transfer of any of the free skin flaps, or free musculocutaneous flaps, for a defect this large would clearly have transferred too much bulk. In her case, the use of a free omentum on a microvascular anastomosis to cover the skull, followed by a skin graft, provided a very nice mechanism for a one-stage reconstruction that enabled her to proceed with the early wearing of her hairpiece.

Now, the authors report on the use of this procedure in Romberg's, which is, I think, very important. We have had the opportunity to take care of six of these patients. In one of these the Coup De Sabe deformity was quite localized, and limited to the forehead, and lent itself well to local excision. In one other patient the defect extended into the scalp in a young girl, producing a large bald area, and was treated with serial excision and advancement of hair-bearing scalp flaps.