Aesthetic Improvements in Free-Flap Mandible Reconstruction

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Mandible reconstruction with free flaps has become a well-established technique. Efforts are now focused on obtaining superior functional and aesthetic results. Improvements in the quality of the latter are possible with a systematic approach to shaping the bone graft. Important elements in this approach have been defined based on experience in 50 consecutive cases. Preoperative studies include the lateral cephalogram and a transverse plane CT scan from which mandible templates are constructed. These templates are models of the mandible in two planes and are used to shape the bone with a high degree of precision. They allow the bone to be completely shaped while still attached by the pedicle at the donor site. The surgical specimen serves as an additional key visual reference and as a source of measurements to determine overall bone-graft length. Miniplates alone provide sufficient fixation to stabilize the bone as it is shaped segment by segment. Intermaxillary fixation is used only to prevent errors in total bone-graft length. Hemimandible and anterior defects represent two completely different bone-shaping problems. Although the bone-shaping methods described have been developed primarily with the fibula, they have been successfully applied to the scapula and radius donor sites as well.

Mandible reconstruction with free flaps is a time-consuming and technically demanding endeavor. However, it is no longer a novelty and has become established as the method of choice for the majority of mandible defects. Possible exceptions are patients with short bone gaps in the setting of benign disease, very elderly patients, and those who are at high medical risk for a long operative procedure.

Reports on free-flap mandible reconstruction to date have focused on the advantages and disadvantages of the various donor sites available.[1–11] As experience has been gained, it is apparent that results with free flaps are superior to those with previous methods of reconstruction utilizing pedicled osseomyocutaneous flaps, nonvascularized bone grafts, synthetic trays with cancellous bone grafts, or metal prostheses. Wound-healing problems have been minimized with the use of reliable, well-vascularized tissue.[12–14]

As the immediate wound problems have been largely solved, attention has shifted to improving the functional and aesthetic results of mandible reconstruction. Reports have already appeared on improved dental rehabilitation with the use of osseointegrated implants.[15,16] However, little has been done as yet to develop a systematic approach to shaping the bone that consistently achieves the highest-quality aesthetic result.

This report focuses exclusively on the development of a technique for reconstructing a missing segment of mandible with a high degree of anatomic precision. This is the key to avoiding facial asymmetry and achieving the best result possible. This technique has been gleaned and refined from lessons learned in 50 consecutive free-flap mandible reconstructions performed over a 3-year period.

Patients and Methods

All mandible reconstructions were performed for cancer. The majority of lesions were epidermoid carcinomas, but a variety of other histologic types also was included (Table I). The complexity of the reconstructions varied greatly, ranging from "bone only" replacement to massive defects requiring simultaneous replacement of bone, intraoral soft tissue, and external soft tissue (Table II). The bone defect ranged from 5 to 17.5 cm (average 12.25 cm). Forty-three patients had

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Presented at the Annual Meeting of the American Society of Plastic and Reconstructive Surgeons, in Toronto, Canada, on October 4, 1988.

TABLE I
Preoperative Diagnoses

Diagnosis	No. of Patients
Epidermoid carcinoma	31
Osteogenic sarcoma	5
Adenoid cystic carcinoma	2
Lymphoma	2
Mucoepidermoid carcinoma	2
Ameloblastoma	1
Leiomyosarcoma	1
Melanoma	1
Ossifying fibroma	1
Osteoradionecrosis	1
Spindle cell sarcoma	1
Prosthesis extrusion	1
Bone graft atrophy	1

primary reconstructions; 7 were secondary. Donor sites included the fibula (42), scapula (3), radius (3), and ilium (2). Interosseous wire fixation was used in the first 4 patients, and miniplate fixation was used in the remaining 46. Four patients had received radiation preoperatively, and 28 received radiation postoperatively. Three patients received postoperative chemotherapy.

Preoperative Studies

Two studies are critical to achieving an accurate bony reconstruction. One is the lateral cephalogram, and the other is a transverse plane CT scan of the mandible. An image is selected from the latter study at a level that shows the shape of the bone from angle to angle. This particular view is magnified and reproduced on a 1:1 scale. Templates of thin, clear acrylic plastic are then made from tracings of this CT view and the lateral cephalogram (Fig. 1). This provides models of the mandible in two planes. These templates are of proven value. They provide an important reference for planning the angle of each osteotomy in the graft. They also allow the graft to be almost completely shaped while still attached by the pedicle at the donor site.

The Panorex is also useful to refer to at the time the graft is shaped. Although the Panorex represents a distorted view of the mandible, it is useful to provide an overall gestalt of mandible shape. The goal of the bony reconstruction from an aesthetic standpoint is to reproduce the contour of the inferior border of the mandible. The alveolus, anterior ramus, and coronoid process are far less important in the definition of facial appearance. Subtle nuances in the shape of the inferior border can sometimes be best appreciated from the Panorex.

Other studies are less useful. Although preoperative facial photographs are important in conventional aesthetic surgery, they do not make a meaningful contribution to achieving the best results in mandible reconstruction. The amount of facial edema that occurs during these lengthy procedures is extensive. In addition, the facial features are considerably distorted by the maneuvers necessary for achieving adequate exposure. The subtle soft-tissue information provided by photographs becomes irrelevant in this setting. Photographs are generally not necessary, except perhaps for documentation purposes. Three-dimensional CT scans, while providing interesting images, also have proven to be of little practical value for either preoperative planning or guiding the reconstruction intraoperatively.

Aside from studies that contribute to the quality of the reconstruction, a cardiac stress test and pulmonary function studies are routinely obtained. These are essential to identify patients who constitute a prohibitive medical risk for free-flap mandible reconstruction.

TABLE II
Defect Characteristics

Bone Defect*	No. of Patients
L	14
LC	7
LCL	12
H	16
HC	1
Soft Tissue Replaced	**No. of Patients**
None†	17
Mucosa	17
Mucosa and skin	7
Skin	9

*After Jewer et al.[4] H and L both denote a lateral mandible component. The former includes the condyle, and neither, when listed alone, significantly crosses the midline. C denotes a central or anterior arch segment that includes both lower canines.

†Muscle bulk included with bone but no surface lining.

Donor-Site Selection

Osseous requirements for an optimal reconstruction of the mandible include adequate bone length, consistent shape throughout the length of the bone, and a vigorous as well as anatomically predictable blood supply. There is usually also a need for the bone to have adjacent muscle and skin of the proper volume and insetting flexibility for reconstructing associated soft-tissue defects. The soft-tissue defect may include intraoral lining, external skin, or both. In addition, there is almost always a muscle defect in the submental and submandibular triangles. This typically occurs with resection of the mandible, although its significance has not been widely appreciated.

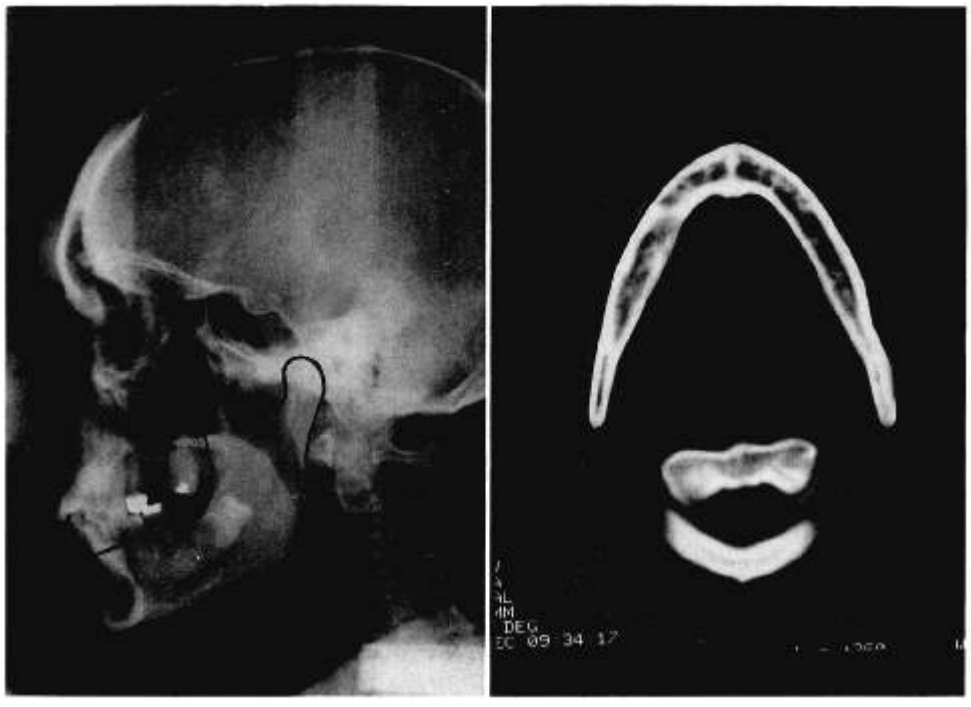

FIG. 1. (*Left*) The mandible contour is shown marked on the lateral cephalogram. (*Right*) The contour in the transverse plane is marked on the CT scan image reproduced on a 1:1 scale. Templates of flexible clear acrylic are cut out from these tracings for intraoperative use.

Failure to reconstruct this particular defect not only leaves a "dead space" with adverse wound-healing implications, but results as well in a hollow appearance under the jawline that compromises the long-term aesthetic result.

Available donor sites for free-flap mandible reconstruction include the ilium, radius, metatarsal, scapula, and fibula. Each has inherent advantages and disadvantages. These include the amount and quality of bone and skin available and the practicality of the donor site in terms of its location, ease of dissection, and associated morbidity.

The choice of donor sites for mandible reconstruction has frequently been determined by the familiarity of the surgeon with a particular technique. However, each patient presents a unique problem, and donor-site selection should be determined instead by the specific bone and soft-tissue requirements of the defect. There is no single donor site that can be used for all situations. Although a critical comparison of the available donor sites is beyond the scope of this report, certain generalizations can be made regarding the quality and relative amounts of bone, muscle, and skin provided by each.

Radius

The radius donor site suffers from a paucity of tissue, both bone and muscle. The bone is available as only a single cortex and is limited to a length usually not exceeding 10 cm. There is also insufficient soft tissue available to fill in the submental and submandibular triangles. As mentioned earlier, this problem tends to result in a hollowed-out appearance to the neck. This is particularly exaggerated when this donor site is selected for reconstruction of the anterior arch of the mandible, a practice that is not recommended. Moreover, there have been reports of pathologic fracture at the donor site when the radius has been used.

Metatarsal

This donor site is similar to the forearm. It has no significant advantages in terms of the amount and quality of tissue available.

Scapula

The scapula provides up to 14 cm of bone and an abundant skin island with great insetting flexibility. The bone is wider and longer than the radius, but it is quite thin. The skin island, in contrast, can be quite thick, and muscle is not available unless the latissimus dorsi is raised as a separate (but attached) flap. However, this further prolongs harvesting the flap, a process that is already delayed because it usually does not begin until the resection is complete and the patient is repositioned.

This donor site is recommended mainly for composite defects with an *enormous* combined internal and external soft-tissue component. In these patients, the aesthetic quality of the reconstruction is severely compromised beforehand, and efforts are more appropriately directed to wound-coverage issues. However, the scapula can be used for a precise aesthetic reconstruction in some patients. It is even possible to use the latissimus dorsi to simultaneously reconstruct the deformity resulting from radical neck dissection.

Ilium

The ilium offers an abundant amount of bone, although its shape is problematic. This donor site was originally attractive because the shape of the bone resembled a hemimandible. Today, however, there are other alternatives that allow a more accurate hemimandible reconstruction without the fixed-shape limitations of the ilium.

The ilium is particularly difficult to work with in the case of extensive anterior arch reconstructions. The shape of the bone cannot be controlled with much precision in this setting compared with other donor sites. Although it still yields a result superior to non-free-flap alternatives, it nevertheless is far from ideal for this application.

The soft tissue associated with this donor site is usually quite bulky, relatively fixed to the bone, and frequently has an unreliable blood supply. The internal oblique muscle has been used in conjunction with the ilium in an attempt to overcome these deficiencies.[11] However, the shape limitations of the bone remain, and the soft tissue is less desirable than skin, particularly if it is used externally on the face.

Fibula

The fibula provides as much as a 25-cm segment of bone, more than enough to reconstruct any mandible defect. It has a consistent shape throughout its length, a characteristic that facilitates the contouring process. Owing to an excellent segmental periosteal blood supply, the fibula can be osteotomized as many times as necessary to reproduce subtle nuances in mandible shape. *This bone represents the ideal raw material for replacing a missing segment of mandible with great precision.*

The flexor hallucis longus muscle lies adjacent to the fibula along much of its length. It is useful for filling in the soft-tissue defect in the submental and submandibular triangles. This contributes significantly to reestablishing a normal neck contour.

Additional experience with this donor site has shown that concern raised over the skin-component blood supply has been exaggerated.[3] A skin island can be reliably included with the bone in over 90 percent of patients. The size available can be as large as that of the scapula donor site, although a skin-graft closure is necessary for large skin islands. The skin associated with the fibula is thinner than that of the scapula but thicker than that available from the forearm.

All these donor sites were used in this series except the metatarsal. The fibula became the donor site of choice as the series progressed. Its superior tissue qualities and versatility make it well suited for most mandible defects.

Operative Approach

Facial incisions are planned together with the team performing the resection. Lip-splitting incisions are avoided if this will not significantly impair the exposure for resection. The T extension for radical neck dissections must be carefully planned if the external jugular vein is to serve as the recipient vein. It is best to leave the vein attached to either the anterior or posterior skin flap in these cases.

The donor-site dissection and mandible resection are performed simultaneously (unless the scapula is chosen). Careful planning and ongoing communication between the two teams are essential to avoid an unexpected need for more soft tissue or bone than anticipated preoperatively. Most of the osteotomies and fixation necessary to shape the bone can be performed during the time of resection while the flap remains attached at the donor site. The availability of the templates allows this maneuver to be done with great accuracy.

The resected specimen should remain on the recipient-site instrument table after removal and kept available until the bony portion of the flap is completely inset. The specimen is used to obtain accurate measurements of bone length, to appreciate subtle nuances of individual mandible shape, and to perceive more clearly the amount, location, and configuration of the associated soft-tissue defect. It is, of course, important to use a "no touch" technique when examining the tumor specimen as the bone is shaped at the donor site.

The complete sequence of steps in the procedure is to dissect and shape the bone during the time of resection, inset the bony portion of the flap, revascularize the flap, and complete the soft-tissue closure. The shaping of the bone has the

most bearing on the final aesthetic result of the reconstruction.

Shaping the Bone

The bone defect is usually one of two types. Either it is predominantly a hemimandible defect that contains a variable portion of the ramus and most of the body, or it is more of an anterior defect that contains the symphysis as well as an unequal portion of each adjacent body. The type of defect dictates the method of shaping the bone and the sequence of the osteotomies.

Anterior Defects

Reconstruction of anterior defects begins with shaping the bone in the region of the midline and working laterally to each side. Experience has shown that the bone-graft segment corresponding to the anterior portion of the mandible should usually not measure more than 2 cm. Cutting the anterior segment first facilitates fitting each body segment to the anterior piece in a symmetrical fashion.

The osteotomies at each end of the 2-cm anterior segment must be angled correctly in two planes. The body diverges from the anterior segment both in the frontal plane, where it angles upward, and in the transverse plane, where the body angles back from the anterior segment. Failure to appreciate the angle in the frontal plane will result in an abnormal forward rotation of the anterior mandible segment around its long axis. The front surface of the anterior segment does not lie within the arc described by the outer surface of the two body segments, as if the mandible resembled a bucket handle. Instead, the front surface of the anterior segment is independent and relates to the body segments much as the seat of a ferris wheel does to its supporting spokes (Fig. 2).

The anterior segment is fixed to the body segments with miniplates. Fixation is performed at each site with two plates placed in perpendicular planes. This type of fixation provides maximum rigidity against the torsional stress imposed by the lateral mandibular segments.[17] The miniplates are placed on the outer surface and inferior border of the bone, not on the inside surface or upper border. The miniplates are subsequently removed after bone healing is complete in those who are candidates for the placement of osseointegrated implants. The periosteum is *never* stripped from the bone during fixation, since this would devascularize the bony portion of the flap. The proper angle at each osteotomy site is checked with the aid of the templates described previously. Availability of the surgical specimen in primary reconstructions provides an additional means of verifying the proper angle of divergence of the body segments.

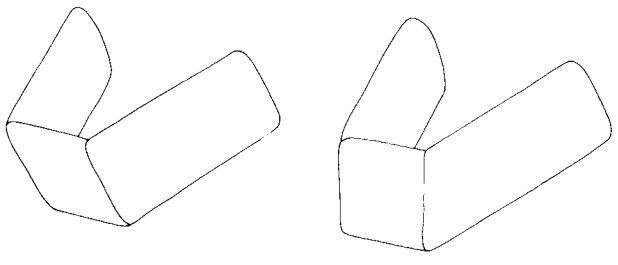

Fig. 2. (*Left*) Incorrect relationship of the anterior segment to the body segments. (*Right*) Correct orientation.

Lateral Defects

Hemimandible defects begin with planning the location of the vascular pedicle so that it comes to lie at the angle of the mandible. The portion of the bone graft corresponding to the angle is therefore shaped first. In most patients, only one osteotomy is required. In some, however, the angle has a gradual curve, and this is best simulated by performing two osteotomies. This maneuver leaves a small wedge of bone between the ramus and body, which softens the angle between the two (Fig. 3, *left*). Fixation is planned so that it spans all three segments in this case.

There is an additional matter to consider while forming the angle of the mandible. The ramus of the mandible diverges at a small angle away from the body when the mandible is viewed from the front. It is helpful to examine the resected specimen as a guide to setting the proper angle between the ramus and body. This information is not provided by either template.

The body is usually shaped with one or two osteotomies. In most patients, one osteotomy in the midportion provides a means to curve the body in a transverse plane as well as to angle it slightly in the lateral view. In a few patients, the shape of the mandible is better reproduced in the lateral view by performing an additional osteotomy near the angle of the mandible (Fig. 3, *right*). As described for anterior reconstructions, almost the entire bone graft can be shaped and fixed while it is still attached at the donor site. Both ends of the hemimandible graft are left purposely long. The final length of the whole graft is determined during insetting at the recipient site.

Correct posterior facial height is important for

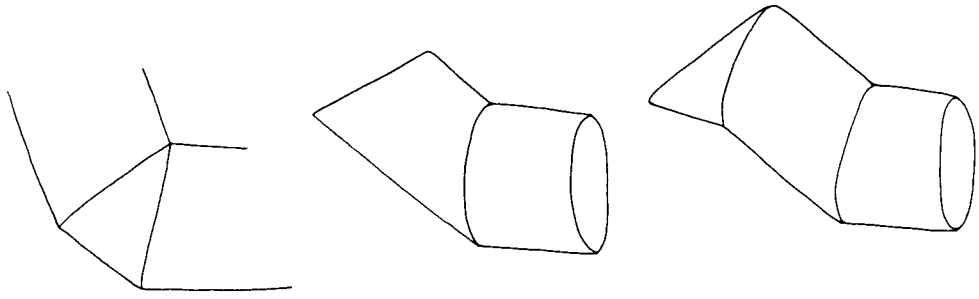

FIG. 3. (*Left*) Two osteotomies are needed to create a gradual curve of the mandible angle in about 10 percent of patients. Correct body shape in both the transverse plane and lateral views can be accomplished with either (*center*) one (most common) or (*right*) two osteotomies.

both function and appearance. Resections planned close to the condyle preclude the possibility of gaining adequate exposure for fixing the graft to the condyle segment with miniplates. When a high ramus osteotomy appears necessary, it is better to remove the specimen with the condyle still attached. The condyle is then resected from the specimen just below the neck. The specimen side of the margin is examined by the pathologist by submitting scrapings of the bone. If the margin is confirmed to be free of disease, the condyle is fixed to the free flap as a conventional bone graft.

Although condyle size has diminished by as much as one-third in several patients followed for at least 3 years with serial CT scans, there has been no long-term loss in function. Both occlusion and opening ability are excellent with this technique and have remained stable. No condyle grafts have required removal for any reason, and trismus has not occurred. This method is preferred to the alternatives of either using a prosthetic condyle or not replacing the condyle and instead leaving a space. A more detailed analysis of this use of the condyle will be presented in a forthcoming study.

INSETTING THE FLAP

Overall bone length must be precisely determined during the final insetting of a hemimandible graft. An error in length generally results in perceptible asymmetry even when the mistake seems quite small. Errors can be reduced by taking careful measurements of the overall length of the surgical specimen. Intermaxillary fixation is used to maintain the opposite side in occlusion as the flap is inset. This also reduces the chance for a length error to occur by preventing displacement of the mandibular midline as the bony portion of the flap is fit into the defect.

The transverse plane CT template is used to assess the overall curve of the mandible as the bone flap is joined to the normal mandible anteriorly. This usually requires exposing the inferior border of the normal side for a considerable distance. This maneuver brings into view the curve of the normal side to compare with the reconstructed side. It also facilitates the fit of the template as a final check on the overall shape of the mandible. An incorrect curve contributes to noticeable asymmetry.

A more subtle but equally important determination is the final position of the angle of the mandible on the reconstructed side with respect to the angle on the normal side. They must be equidistant from the midsagittal plane. Otherwise, the face may appear either caved in or bowed out on the reconstructed side when the patient is viewed from the front. Similarly, the angles must be on the same transverse plane to avoid asymmetry. The templates do not guarantee correct angle position. The final position of the angle sometimes has to be intuitively adjusted based on palpation of both sides.

Total graft length is also critical in anterior mandible reconstruction. Errors in body-segment length can easily result in either prognathism, retrognathia, or displacement of the midline if an error in measurement is made only on one side. In addition, lower facial height is increased by abnormally long body segments that not only cause excessive anterior projection but excessive inferior projection as well. The opposite problem occurs when the body segments are too short. Unfortunately, even correct body-segment length does not guarantee against distortions of lower facial height. The graft must join the lateral mandibular segments at the proper angle when viewed from the side. Otherwise, the anterior portion of the mandible will be either tilted superiorly, tilted inferiorly, or even twisted if the opposite error is made on each side. Finally, errors in length of the body segments or errors in their angle of divergence from the anterior seg-

ment can cause the lateral mandibular segments to be displaced either medially or laterally, or be internally or externally rotated.

Results

There was one flap lost due to venous thrombosis. All other flaps survived. Bone healing was monitored in all patients with serial Panorex studies. There were two nonunions, one related to recurrent disease and the other to fracture of a miniplate. The latter healed with plate replacement. All other grafts healed, and there was no clinical or radiographic evidence of delayed healing in those receiving postoperative radiation therapy. Four patients required removal of miniplates after the bone was stable because of either wound breakdown or soft-tissue infection. These wounds healed completely once the plates were removed.

No attempt was made to categorize the quality of the aesthetic result in each patient. A rating system would have minimal value because the success of the methods described was self-evident when they were properly employed. Similarly, results in terms of dental reconstruction were not tabulated because functional issues, although obviously important, were not the primary focus of this report. A successful dental reconstruction only enhanced the aesthetic result when it was achieved.

Discussion

There are many issues still unresolved in mandible reconstruction. These include the indications for primary versus secondary repair, the effects of radiation on bone healing and future osseointegrated implant placement, donor-site selection, and the role of prosthetic reconstruction techniques. The purpose of this report is to discuss methods that can produce the best aesthetic results possible in mandible reconstruction, a largely separate issue that has received very little attention to date.

Evaluation of the aesthetic results in mandible reconstruction is judged on "soft" data and is somewhat arbitrary in the final assessment of each patient. Nevertheless, much can be gained by an analysis of factors that can contribute to improved results.

It has become clear during the course of this study that a secondary approach to reconstruction of the mandible has major disadvantages from an aesthetic viewpoint. For example, in secondary cases, the mandibular segments no longer have the original spatial relationship to one another and the true dimensions of the bone defect are not known. The surgical specimen is not available for reference, and it is difficult to make accurate templates of the mandible preoperatively. Moreover, the amount of soft tissue needed for the reconstruction is pure conjecture, since the actual amount missing is disguised by contracture of the remaining soft tissues. In some cases, however, all these disadvantages must be accepted if there is a particularly compelling reason regarding the disease process not to perform a primary reconstruction.

The bone and soft-tissue components contribute separately to the potential for an excellent aesthetic result in mandible reconstruction. Intraoral soft-tissue loss actually has little influence on the quality of the result, provided that the missing amount is replaced. Moreover, the degree of precision needed for intraoral soft-tissue reconstruction is not high. Most of the bone donor sites currently available have soft-tissue components that can be used for this purpose.

There are two specific types of soft-tissue defects that severely limit the aesthetic quality of the reconstruction, however. One is the large mandible tumor that invades the deep soft tissues of the cheek. If ablation requires sacrifice of the facial nerve, a suboptimal aesthetic result almost always occurs despite a precise bony reconstruction and replacement of the missing soft-tissue volume. The second instance is that of the large tumor that has invaded the skin anteriorly. Although an accurate bone reconstruction and skin replacement can be achieved, the quality of the result is limited by the patch-like appearance of the skin island and problems with lower lip tone and chronic edema. Lip-splitting incisions are another, albeit far less severe, predetermined soft-tissue factor that often lessens the quality of the aesthetic result.

Although difficult, the bone can be quite accurately reconstructed. When not limited by uncontrollable soft-tissue factors, the quality of the result will be determined directly by the accuracy of the bony reconstruction. Prevention of bony asymmetry is therefore the goal of the graft-shaping process. It is now possible to precisely duplicate mandible shape using vascularized grafts (Figs. 4 to 7).

There are a number of important elements in the current approach to shaping the bone graft. Certain preoperative studies such as the Panorex, lateral cephalogram, and a CT scan of the man-

FIG. 4. (*Above, left* and *right*) Postoperative views, primary total left hemimandible (H) reconstruction with fibula following resection of an osteogenic sarcoma and suprahyoid neck dissection. The mucosal defect did not require replacement with a skin island. No postoperative radiation was given. (*Below, left* and *right*) Postoperative views, secondary subtotal left hemimandible (LC) reconstruction with scapula. This followed previous resection of a gingival epidermoid carcinoma and an ipsilateral supraomohyoid neck dissection. No radiation therapy was given. Skin was not needed intraorally for the reconstruction.

dible have proven to be of exceptional value. The fabrication of templates based on the latter two studies provides a very accurate means of determining graft shape in two planes. The surgical specimen is an another important adjunct. It provides precise measurements as well as a visual reference for the configuration of the bone and soft-tissue components of the defect. Miniplates

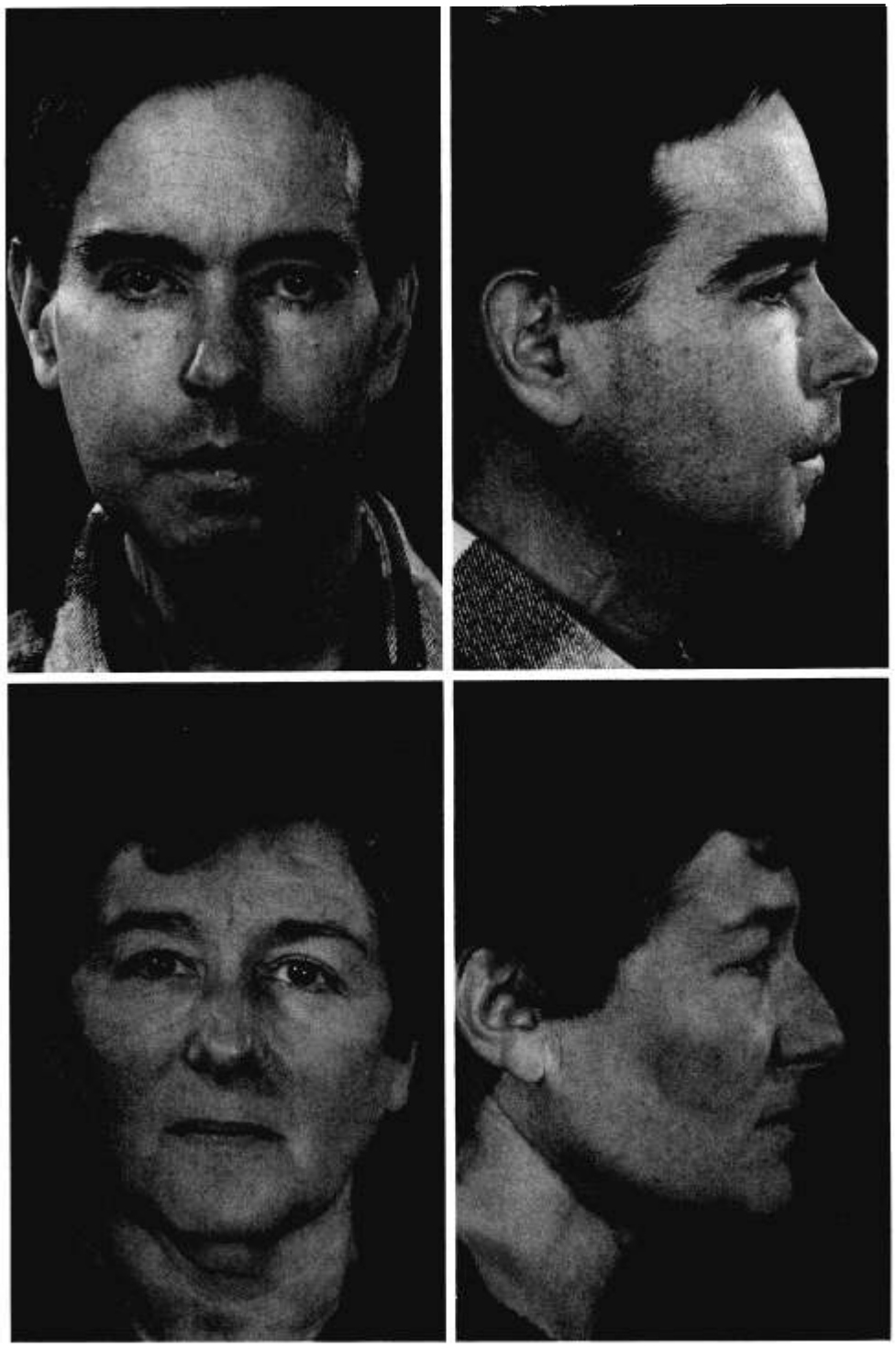

FIG. 5. (*Above, left* and *right*) Postoperative views, primary subtotal right hemimandible (H) reconstruction with fibula for a $T_4N_2M_0$ epidermoid carcinoma of the floor of the mouth. Resection included the floor of the mouth, adjacent buccal mucosa, a hemiglossectomy, and a radical neck dissection. A large skin island was folded lengthwise to replace the floor of the mouth and reconstruct half the tongue. A full course of postoperative radiation followed. (*Below, left* and *right*) Postoperative views, primary subtotal right hemimandible (H) reconstruction with fibula following resection of an intraosseous mucoepidermoid carcinoma of the mandible. A skin island was not required, and postoperative radiation was not indicated.

FIG. 6. (*Above, left* and *right*) Postoperative views, primary subtotal right hemimandible (H) reconstruction with fibula following resection of an adenoid cystic carcinoma limited to bone. A supraomohyoid dissection also was performed. No mucosal replacement was needed. A full course of postoperative radiation therapy was given. (*Below, left* and *right*) Postoperative views, primary subtotal right hemimandible (LC) reconstruction with fibula following resection of an ulcerating lymphoma of the mandible. A skin island measuring 6 × 3 cm was included for intraoral closure. Postoperative treatment included radiation and chemotherapy.

facilitate the graft-shaping process by adequately stabilizing the graft from segment to segment as it is shaped. They do not interfere with overall shape because they have little bulk. Other forms of fixation are unnecessary. Intermaxillary fixation is used only to prevent errors in graft length by maintaining occlusion of the normal mandibular segment as the final fitting of the graft takes

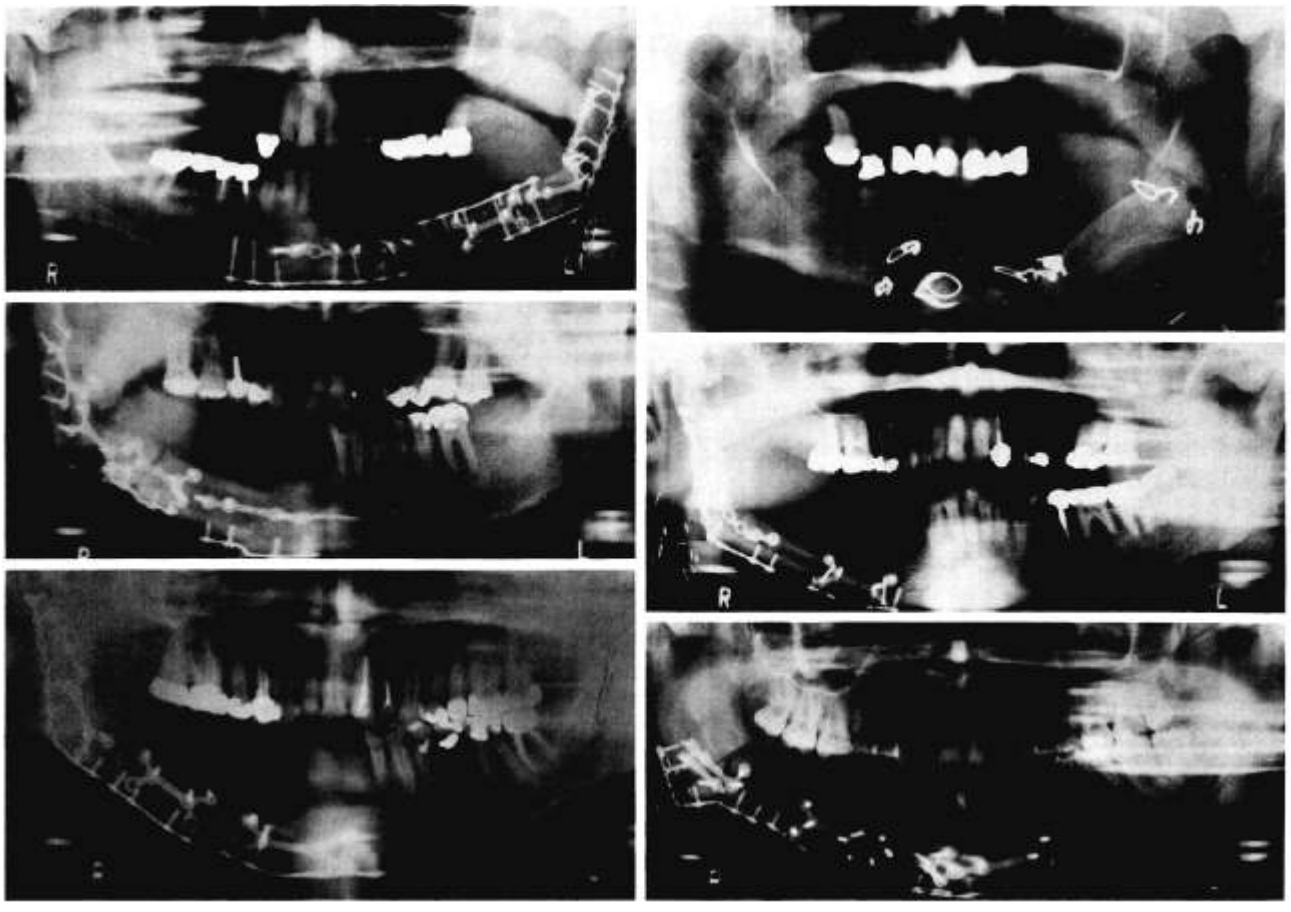

FIG. 7. Panorex views for Figures 4, 5, and 6. (*Above, left* and *right*) Figure 4. (*Center, left* and *right*) Figure 5. (*Below, left* and *right*) Figure 6. Note the symmetry of the inferior border of the mandible.

place. Although the quality of the aesthetic result is not necessarily dependent on the donor-site choice, the fibula is the most versatile bone stock currently available for reconstructing the mandible with a high degree of precision.

A matter that is not readily apparent from the preceding presentation is that mandible reconstruction requires considerable sculptural skill. An understanding of three-dimensional form and facility in its complex manipulation are essential.[18] Equally important is an intuitive sense that reliably selects the correct maneuver needed to achieve the desired shape. This is something that is not always suggested from either measurements or the templates.

CONCLUSIONS

1. Primary reconstruction of the mandible affords the best opportunity for a superior aesthetic result.
2. The surgical specimen is a key reference for shaping the bone graft and planning soft-tissue replacement.
3. The most important goal in shaping the bone is to restore precisely the three-dimensional contour of the *inferior border* of the mandible.
4. Mandible templates are essential tools for accurately shaping the bone graft. These templates allow the bone to be shaped while still attached at the donor site.
5. Miniplate fixation facilitates the bone-shaping process. Intermaxillary fixation is used only for preventing errors in graft length.
6. The fibula provides the ideal bone stock for consistently achieving an excellent aesthetic result in mandible reconstruction.

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