

# Immediate Function of Temporomandibular Joint After Total Resection and Reconstruction

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Two patients with recurrent parotid gland carcinoma required subtotal petrosectomy and infratemporal fossa type C approach. To achieve en bloc resection, the ascending mandibular ramus and the entire temporomandibular joint, including the adjacent temporal bone, were removed. An original technique for immediate reconstruction of the infratemporal region, including the glenoid fossa and the ramus of the mandible, is described. Rigid fixation, as well as good functional and aesthetic results, was achieved with autologous calvarial bone and full-thickness rib grafts, allowing the patients to mobilize their jaw very rapidly.

**Key Words:** Immediate function after tumor surgery, TMJ reconstruction, autologous graft, infratemporal fossa approach, petrosectomy

To be efficient, oncological surgery is often mutilating. When the base of a skull is invaded by cancer, the surgical approach necessary for adequate exposure [1,2] and tumor resection often results in cranial nerve deficits, neurological impairment, and disfigurement. Postoperative morbidity can be minimized by reconstructing the removed and often vital structures. The concept of reconstruction requires re-establishing shape and function as correctly as possible.

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Although the choice of immediate versus delayed reconstruction is open to debate, in certain patients with malignant tumor recurrence, the acceptable limits of craniofacial resection are often reached, and further surgery is no longer considered. The reconstruction can thus be immediate and as complete as possible.

We present an original technique of immediate reconstruction of the petrous portion of the temporal bone and of the mandible. This method was used in two cases after en bloc surgical resection of recurrent parotid carcinoma requiring subtotal petrosectomy, which included the glenoid fossa, resection of the mandibular ramus and condyle, and resection of an infratemporal fossa tumoral extension. Although resection of the ascending ramus is mentioned as a possible extension of infratemporal type C approach [1], it does not appear to be used frequently [1,2]. One reason is the lack of an appropriate reconstructive technique.

## PATIENT 1

### History

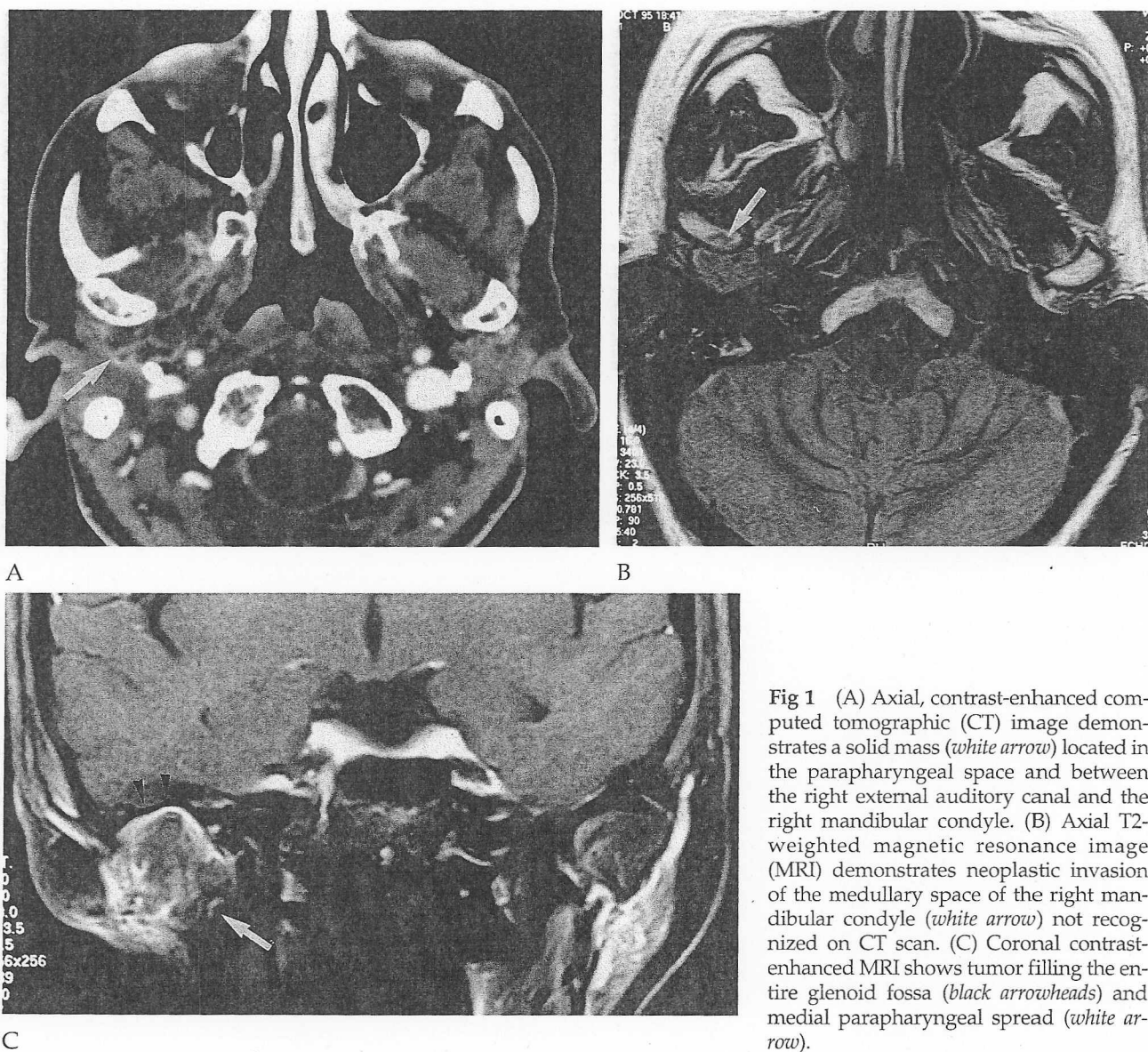
A 58-year-old woman underwent total right parotidectomy in 1994 for a myoepithelial variant of a high-grade adenocarcinoma. The facial nerve was invaded by tumor and was sacrificed. A cable graft using the sural nerve was performed with progressive restoration of facial function (grade III after the House-Brackmann classification [3]). Postoperative radiation therapy was administered, delivering 60 Gy to the tumor bed and the homolateral neck. During routine follow-up 10 months after the initial surgery, the patient complained of right ear fullness. A polypoid mass was noted, the biopsy of which was compatible with an adenocarcinoma, within the external auditory canal. Computed tomographic (CT) scan and magnetic resonance imaging (MRI) (Fig

1A-C) of the skull base confirmed tumor recurrence extending in the external auditory canal and invading the temporomandibular joint (TMJ) and the prestyloid compartment of the parapharyngeal space. The internal carotid artery and jugular vein were not infiltrated. No distant metastasis could be detected by a thoracoabdominal CT scan and a bone scan.

### Resection

With the patient under general anesthesia and nasotracheal intubation, the parotidectomy incision was extended behind the ear lobe to the vertex. Sub-

total petrosectomy was begun by a complete mastoidectomy, a disarticulation of the ossicular chain at the level of the uncudostapedial joint, and the removal of bony and cartilaginous auditory canal. The external ear was closed at the level of the concha. The tip of the mastoid was drilled out to unroof the jugular vein up to the jugular foramen and the petrosal portion of the internal carotid artery. Anteriorly, the temporal squama was drilled up to the middle fossa dura, which was identified above the glenoid fossa. The distal part of the zygomatic arch was then sectioned. Using the reciprocal saw, the posterior part of



**Fig 1** (A) Axial, contrast-enhanced computed tomographic (CT) image demonstrates a solid mass (*white arrow*) located in the parapharyngeal space and between the right external auditory canal and the right mandibular condyle. (B) Axial T2-weighted magnetic resonance image (MRI) demonstrates neoplastic invasion of the medullary space of the right mandibular condyle (*white arrow*) not recognized on CT scan. (C) Coronal contrast-enhanced MRI shows tumor filling the entire glenoid fossa (*black arrowheads*) and medial parapharyngeal spread (*white arrow*).



**Fig 2** Postresectional defect. *Asterisk* indicates the middle cranial fossa dura; *white arrowhead* indicates distal part of the zygomatic arch; *black arrow* indicates the oblique cut of the ramus.

the ascending ramus of the mandible was cut obliquely at the level of the mandibular notch. The mandibular condyle and the entire TMJ were mobilized with the adjacent temporal bone (Fig 2). The resection was continued in the infratemporal fossa until the entrance of the eustachian tube at the level of the nasopharynx. The whole tumor was removed en bloc with tumor-free margins.

#### Reconstruction Technique: Glenoid Fossa and Zygomatic Arch

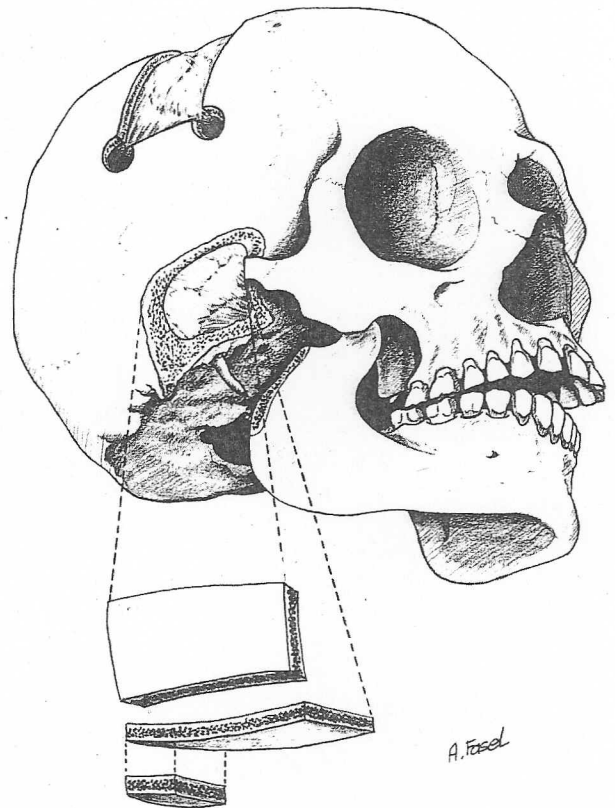
A 6 × 5-cm graft of full-thickness parietal bone was taken. The donor site was filled with autopolymerizing methyl methacrylate resin. An oblong piece of 5 × 2 cm was cut in the bony graft with the reciprocating saw to cover the defect of the squamous portion of the temporal bone laterally and recreate the distal part of the zygomatic arch. A second trapezoid piece of similar dimensions was cut for reconstruc-

tion of the horizontal petrous temporal region. A montage of these two fragments was made by placing them perpendicular to each other (Fig 3) and stabilizing them with a Synthes adaptation eight-hole miniplate bent at 90 degrees. This miniplate was then rigidly fixed to the temporal bone by five mini-screws (6.0 mm long and 2.0 mm diameter). Anteriorly, the montage was stabilized by two miniplates of four and five holes to the remaining portions of the temporal squama and zygomatic arch.

To avoid a posterior slip of the mandible, a third bony graft of 2.0 × 1.5 cm was set subsequently by two lag compression screws [4] under the inferior plate (Fig 4).

#### Reconstruction Technique: Mandibular Condyle

Reconstruction of the head and neck of the condyle of the mandible requires the removal of the anterior part of the fifth rib, using standard techniques. The periosteum and perichondrium were preserved to avoid breaking the costochondral joint. The length of



**Fig 3** Drawing of the reconstruction of the glenoid fossa: montage of the two bone plates perpendicular to each other.



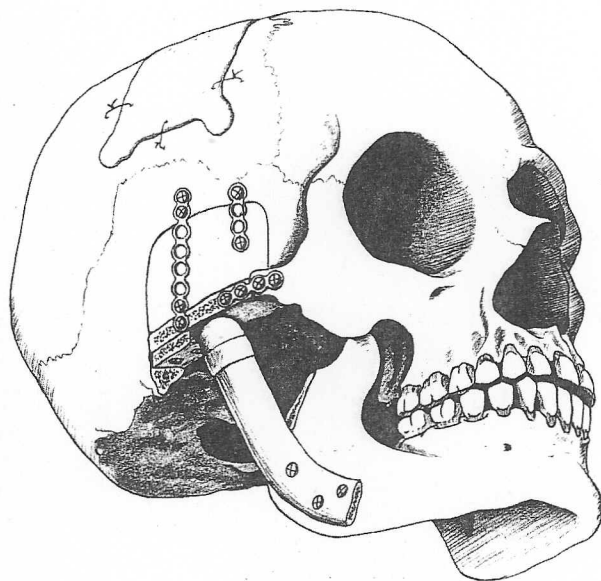


**Fig 4** Glenoid fossa reconstruction: stabilization of the bone plates by means of three adaptation miniplates and lag compression screws fixing the bony abutment to the inferior plate (*white arrow*).

the graft was measured to reach the angle of the mandible, with enough cartilage left to be contoured as a new condylar head.

The costochondral graft was adapted and rigidly fixed to the mandibular ramus by three lag screws, 10 × 2.0 mm, tapered through both cortex of the mandible (Fig 5). A washer was placed on each screw to distribute the compression forces (see example with Patient 2 in Fig 7). A previously raised portion of the temporalis muscle was transposed on the new joint to function like an interposition bush. Temporary intermaxillary fixation (IMF), placed at the beginning of the procedure, was then released and the jaw gently mobilized to check the correct occlusal relationship. No other IMF was necessary. The arch bars were left in place and two soft rubber bands were used for patient's comfort. Primary skin closure was possible.

The evolution was favorable with a buccal aperture of 25 mm on the third postoperative day when



A. Fasel

**Fig 5** Drawing of the reconstruction of the entire temporomandibular joint. Previously described calvarial grafts were used to reconstruct the glenoid fossa and a costochondral graft was used for mandibular ramus reconstruction.

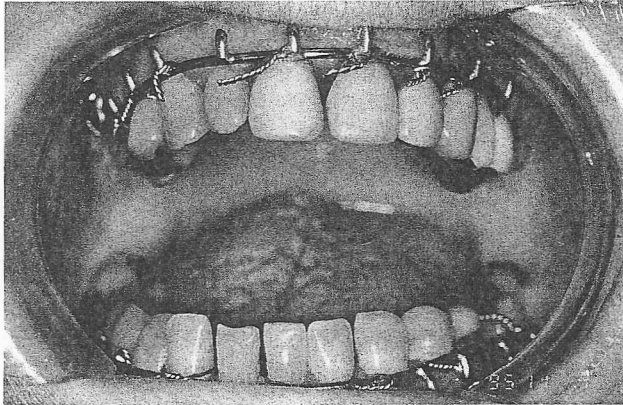
liquid diet was resumed with progression to soft diet on the 10th postoperative day (Fig 6A).

Because the area was already irradiated, no postoperative radiation therapy was given. Follow-up clinical and radiological controls 1 year after surgery showed absence of tumor recurrence. The patient enjoyed a normal diet, a straight mouth opening of 30 mm, and a stable occlusal relationship (Fig 6B). She regained the same weight as before the operation, works full time, and has resumed her favorite sport activities, such as rock climbing and cross-country skiing.

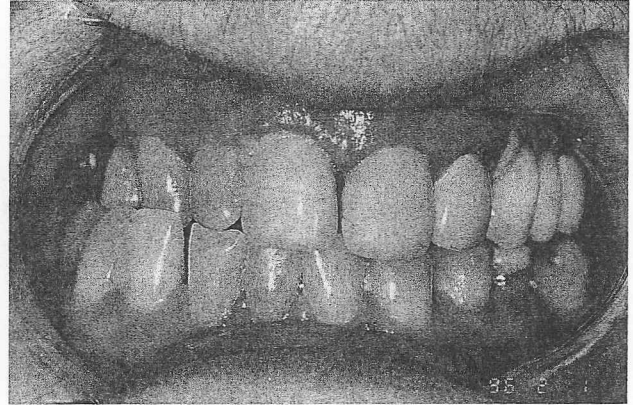
## PATIENT 2

### History

A 52-year-old woman underwent a total right parotidectomy and supraomohyoid neck dissection for a malignant tumor, the exact pathology of which could not be determined by frozen sections. The facial nerve was preserved. The initial postoperative House-Brackmann facial score was III and returned to I within 3 months. The final diagnosis was adenoid cystic carcinoma. A reintervention for resection of the facial nerve was proposed to the pa-



A



B

Fig 6 (A) Mouth opening (28 mm) on the 10th postoperative day. (B) Stable occlusion relationship 1 year postoperatively.

tient, but she refused. A postoperative radiation therapy of 70 Gy was administered.

Eighteen months after the first operation, right partial facial paralysis appeared and progressed rapidly to a complete facial palsy. CT scan and MRI demonstrated tumor recurrence in the parotid bed with superficial extension along the external auditory canal and the skin of the parotid area. Deep extension was present along the ascending ramus of the mandible and the parapharyngeal space. The tumor was located against the mastoid and petrosal part of temporal bone without clear bony invasion. No distant metastasis could be detected by thoracic and abdominal CT scan.

### Resection

Under general anesthesia and nasotracheal intubation, the patient underwent lateral T-bone resection, auriclectomy, resection of a large portion of preauricular facial skin, and radical neck dissection with extension to the upper portion of the trapezius muscle. Anteriorly, the temporal bone was drilled to the dura of middle fossa, identified above the glenoid fossa. The distal part of the zygomatic arch was sectioned. Using the reciprocal saw, the posterior part of the ascending ramus of the mandible was cut obliquely at the level of the mandibular notch and the condyle, and the entire TMJ was mobilized with the adjacent temporal bone. The resection was continued in the infratemporal fossa until the entrance of the eustachian tube at the level of the nasopharynx.

### Reconstruction Technique: Glenoid Fossa and Zygomatic Arch

A 5.2-cm graft was harvested from the outer table of the parietal bone and cut in two pieces. The first

fragment was trimmed to adapt and reconstruct the posterior horizontal part of the glenoid fossa, behind the anterior articular tubercle, which remained partially present. This bone plate was stabilized by means of an eight-hole miniplate bent at 90 degrees and fixed by five miniscrews (2.0 mm in diameter and 6.0 mm long). The second bone piece was cut and placed perpendicularly to the first graft and adapted to prolong the resected zygomatic arch. The graft was fixed with a nine-hole miniplate and six miniscrews (2.0 mm in diameter and 6.0 mm long) to the remaining arch and with a 8.0-mm lag screw to the first graft (Fig 7).

### Reconstruction Technique: Mandibular Condyle

The anterior part of the sixth right rib was removed with its costochondral junction and adapted between the roof of the new glenoid fossa and the angle of the resected ramus. Four 8.0-mm minilag screws with washers were used to immobilize the graft in place (see Fig 7).

### Latissimus Dorsi Myocutaneous Flap

Because a large skin and subcutaneous soft tissue defect was present, a distant flap was used for reconstruction. A 8.5 × 11-cm skin island flap was delineated at the anterior and inferior portion of the latissimus dorsi down to the iliac crest [5]. The entire muscle was elevated and detached from its posterior insertions. The pedicle was dissected to the axillary vessels, dividing the circumflex scapular and serratus anterior vessels as well as the nerve. The humeral tendon was divided. The myocutaneous flap was tunneled under the pectoralis major muscle and over the clavicle. The flap was then brought subcutane-



Fig 7 Patient 2. Definitive aspect of the reconstruction. Note the four washers placed between screws and bone to distribute the compression forces between the costochondral graft and the ramus.

ously in the cheek, filling the auricular and parotid defect. The excess of muscle was folded to fill up the dead space (Fig 8). The secondary defect in the back was closed primarily.

Lagophthalmos secondary to facial palsy was treated by lateral canthoplasty. A dermal flap, including a portion of the upper and lower eyelid margins, was secured to the orbital rim [6].

## DISCUSSION

**O**ncological surgery in the infratemporal fossa remains difficult because the involved structures are deeply located, and wide exposure is required for an en bloc resection with clear surgical margins. Several surgical approaches [1,7,8,9] have been described, all of which tend to avoid either section or removal of the ascending mandible and especially of the mandibular condyle and TMJ. If appropriate re-

construction was available, a more direct and wide exposure could be achieved through a lateral transzygomatic transmandibular approach.

Total resection of the TMJ results in an ipsilateral recess of the mandible, a contralateral open bite, and a limitation of all mandibular movements. The dead space resulting from the combined resection of the TMJ and the infratemporal fossa contents can be filled by a variety of flaps: local rotation muscular flaps [10,11], pedicled myocutaneous flaps [12,13], or free flaps [14]. However, these techniques cannot be considered as "functional reconstructions" because the TMJ is not repaired.

The goal of bony reconstruction after surgical resection is to restore a correct form and to reestablish good function. Ideally, this should be carried out during the same surgical procedure.

In the cases presented here, both the basicranial portion and the condylar part of the TMJ were reconstructed during the same procedure as the oncological resection. Reconstruction of the cranial base must protect the dura and the brain and recreate a glenoid cavity capable of sustaining the tensions developed by the masticatory muscles.

To the best of our knowledge, reports of isolated reconstruction of the temporal, basicranial aspect of the TMJ have not been published.

The distal aspect of the TMJ, namely the ascending mandibular ramus and condyle, was first described by Bardenheuer in 1909 (cited by Lexer [15]) using the fourth metatarsal bone grafts. Autologous costochondral grafts, initially described by Poswillo in 1974 after experimental studies on monkeys [16], is the most frequently used graft today. Five main indications have been discussed: congenital malformations, TMJ ankylosis, reconstructions after resections for cancer, posttraumatic sequelae, and certain degenerative lesions of the articulation [17,18,19].

Publications on techniques of total TMJ reconstruction, including both the temporal and mandibular aspects, are sparse. Initially described by Obwegeser in 1974 [20] for patients with otomandibular dysostosis syndrome, this procedure was later used by Freihofer and Perko to repair a posttraumatic loss of total TMJ after an explosive accident [21].

These techniques used split autologous rib and iliac grafts for the temporal side of the joint and whole rib for the condylar side. Fixation was achieved by wires, and these semirigid montages required a prolonged mandibulomaxillary fixation, which precluded an immediate masticatory function. These procedures were also complicated by a high infection rate [21] and the long-term resorption of the cartilaginous graft.



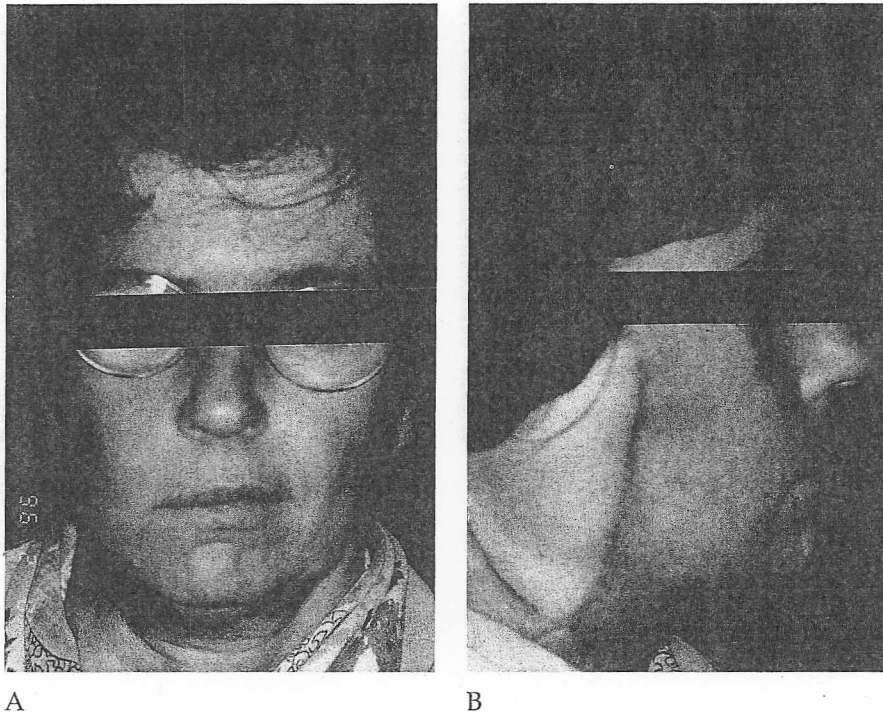


Fig 8 (A,B) Patient 2 postoperatively. Note the skeletal symmetry, with chin and nose on the same sagittal plane, despite facial palsy.

To sustain the tension developed by the masticatory muscles and protect the overlying temporal lobe, a highly solid and steady support is necessary. The calvarial bone is of membranous origin, is highly resistant, and sustains less resorption than iliac bone grafts [22]. It can be cut with a saw and modeled by drilling. Because it is essentially made of cortical bone, it has the advantage of offering a dense and compact anchorage for the retention of the miniaturized screws.

Solid fixation is not achieved when costochondral graft is attached to the remaining mandibular ramus with metal wires. Furthermore, when the steel wires are well tightened, they induce a resorption of the adjacent bone, which decreases the compression between the rib graft and the mandible. Often the fixation becomes loose, with a false mobility of the graft, and results in high risk of infection and pseudoarthrosis. The unstable nature of this osteosynthesis requires a long-term mandibulomaxillary fixation.

If the lag screw principle [4] is used, immediate stability can be achieved. To prevent erosion of thin rib cortex by the head of the screws, it has been suggested to use miniplates to distribute the compression forces [23]. We believe that, by using only fragments of miniplates, cut as washers, it is possible to obtain the same result and decrease the quantity of implanted material.

For the two cases of recurrent parotid cancer, this operation was the ultimate therapeutic possibility and no further radiation therapy could be administered. If postoperative radiation had been planned, a better reconstruction graft could have been a revascularized bone graft [24], especially for our first patient. For the first patient, the only nonirradiated soft tissue brought to enhance the vascularization of the nonvascularized autologous bone and cartilage grafts was a partial temporalis rotational muscle flap. No infection occurred despite previous radiation therapy and the presence of some dead space at the completion of the procedure. For the second patient, a large myocutaneous flap was required to cover the skin defect and ensure a sufficient protection of the grafts. The achievement of primary stable fixation is certainly the main reason for such a favorable outcome.

#### CONCLUSION

It is possible to apply rigid internal fixation principles to the reconstruction of the temporomandibular region. Immediate restoration of function and rapid recovery without major complications have numerous advantages for patients undergoing oncologic resection.

The good functional and aesthetic results after more than 1 year are encouraging, and we tend to

propose this technique for the correction of certain temporomandibular malformations as well as post-traumatic sequelae.

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