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Experiences with Intra-Oral Partial Resection and Simultaneous Reconstruction of the Mandible in Preoperatively Non-Infected Cases

Hermann F. Sailer

Maxillo-Facial Surgery Clinic (Head: Prof. H. L. Obwegeser, M.D., D.M.D.), Medical Faculty, University of Zurich, Switzerland

Summary

The results of 21 partial resections of the mandible with simultaneous reconstruction via the oral route are described. The patients were seen 1 to 14 years after the operation. Main criteria of this follow-up study were aesthetics, function of the temporo-mandibular joint, occlusion, chewing function, sensibility, function of facial nerve, behaviour of transplants and complications. In only 1 case did the transplant have to be removed due to osteomyelitis. 3 times a pseudarthrosis developed. The good results lead to the conclusion that simultaneous reconstruction of the mandible via the oral route is the method of choice in the treatment of benign and low grade malignant tumours.

Key-Words: Bone transplantation; Immediate reconstruction of the mandible; Tumour management.

Introduction

The effective treatment of mandibular tumours with associated extension (whether benign, of low-grade or of high-grade malignancy) can only be accomplished by resection of the affected segment of the mandible. The resulting situation is always a serious problem for the patient from the aesthetic, psychological, and functional standpoint. These problems are best solved by immediate reconstruction of the resected mandibular segment.

We believe that the results of reconstruction as described above may vary, depending on the pathophysiological circumstances. In particular, they depend upon wheter an infection is present preoperatively or not and upon whether the resection and simultaneous reconstruction is for an irradiated or primary low-grade malignancy.

In the maxillo-facial surgery clinic at the University of Zurich, both tumour patients and patients with osteomyelitis are treated with simultaneous intra-oral resection and reconstruction. In the following paper the results of this method of treatment for a group of patients affected with large cysts and with benign and semi-malignant tumours of the mandible without accompanying osteomyelitis is reported.

Patient Material

The group investigated consists of 12 male and 9 female patients with an average age of 27 years. The youngest was 3 years of age and the oldest 50. Two were edentulous. The diseases leading to resection and simultaneous reconstruction are listed in *Table 1*. The principal indications for this procedure were benign and low grade malignant tumours.

Table 1 Diagnosis of 21 preoperatively noninfected cases with resection and simultaneous reconstruction of parts of the mandible via the oral route.

Ameloblastoma	8
Fibromyxoma	3
Giant cell tumour	3
Multiple cysts	1
Epidermoid cyst	1
Osteoma	1
Fibroma	1
Chondroma	1
Chondroblastoma	1
Fibrous dysplasia	1
Total	21

Method

The resection of the affected mandibular segment is accomplished intra-orally even if disarticulation is required. The dissection includes some adjacent soft tissues and is a subperiostal resection mesial and distal to the tumour region. After resection, the remaining mandible is fixed to the maxilla, and the reconstruction is also performed via the intra-oral route in the manner described by *Obwegeser* (1960). The following principles, as stated by *Obwegeser* (1963, 1966) are observed:

1. Transplant bone with minimum cortex.
2. Ensure large cancellous contact areas between the graft and stump, with cancellous "mush" placed between the two.
3. Produce good apposition, if possible under pressure.
4. Use prophylactic antibiotic therapy, including local application of broad-spectrum antibiotics – as irrigations during surgery.
5. Avoid dead space in the area of the graft in which a haematoma may form.
6. Use well-approximated, everted, soft-tissue closure, with meticulous mucosal sutures.
7. Provide absolute immobilization, whenever possible, by means of intermaxillary fixation.

The intermaxillary fixation remains in place for 6 weeks. However, we are not afraid of reconstruction in edentulous patients without intermaxillary fixation. Continuous antibiotic coverage is utilized, beginning one day before operation and maintained for about 10–14 days after operation.

For the simultaneous reconstruction of defects in the region of the symphysis and body of the mandible, including the angle, autogenous iliac crest or rib bone, without periosteum is used. After disarticulation, only iliac crest bone was used for the reconstruction of the ramus, angle and body of the mandible in the series presented. For reconstruction of the condyle, the end of the graft is carefully shaped to fit into the empty glenoid fossa properly. The articular disc is left in situ.

The cortical layer of bone on the graft is thinned. The graft is always rinsed with an antibiotic solution and apposed to the remaining mandible either with a broad onlay or inlay technique and fixed to it with direct wires. Special care is taken to prevent voids around the graft and usually, one or two vacuum drains are left along the graft for some days.

Results

In 13 patients iliac crest was used as the donor site for the graft. In 8 cases the 7th or 8th rib was utilized for reconstruction. The patients were evaluated between 1 and 14 years postoperatively. They were evaluated according is the following criteria:

A. Aesthetic result
B. Functional result
   I. Condylar movement
   II. Disturbances of occlusion
   III. Masticatory function
   IV. Sensibility
   V. Motor disturbances
C. Behaviour of the graft
D. Complications
E. Additional operations

A. Aesthetic results

The following criteria were used to evaluate the aesthetic results:

"Excellent": The specialist cannot differentiate between normal and operated sides during function.

"Good": Slight difference in contour extra-orally between the operated and normal side which is neither apparent to the layman as an abnormality nor disturbing to the patient.

"Fair": The operated side can be differentiated from the normal side, but the difference is not great enough for further treatment from the patient's or surgeon's standpoint.

"Poor": Patient and surgeon desire further surgical correction because of asymmetry of contour. As shown in *Table 2* the aesthetic result was excellent in 14 and good in 7 patients. No patient had a fair or poor result.

Table 2 Cosmetic results after resection and simultaneous reconstruction of the mandible as postulated and defined above.

Aesthetic result	Patients
"Excellent"	14
"Good"	7
"Fair"	0
"Poor"	0

B. Functional results

B. I. Condylar movement

1. Mouth opening: 36 mm interincisal distance or more is considered normal. With the exception of one patient with limited mouth opening of 32 mm (initially 39 mm) because of partial ankylosis 6 years after disarticulation and reconstruction. The average mouth opening for the series was 40 mm.
2. Lateral movement towards the healthy side and anterior movement graded as:
   a) normal
   b) slight limitation
   c) severe limitation
   d) no movement.

   In 17 patients without reconstruction of the condyle the lateral and anterior movement was normal or slightly limited. 3 patients with condylar reconstruction had severe limitation or no movement of the condyle; the other 8 with condylar reconstruction showed normal or slightly limited movement of the condyle. The results are summarized in *Table 3*.

Table 3 Synopsis of condylar movement in patients with and without condylar reconstruction: Mouth opening, lateral and anterior movement.

Patient	Mouth opening (mm)	Lateral movement toward the healthy side	Anterior condylar movement on the reconstructed side	Condylar reconstruction
V. P.	40	normal	normal	yes
W. K.	39	slight limitation	normal	yes
H. W.	41	normal	normal	yes
H. P.	41	normal	normal	yes
S. H.	39	great limitation	no movement	yes
B H.	32 (36)	no movement	no movement	yes
S. I.	36	slight limitation	slight limitat.	yes
P. F.	57	normal	slight limitat.	yes
P. R.	42	slight limitation	normal	yes
L. M.	38	great limitation	no movement	yes
G. M.	40	slight limitation	slight limitat.	yes
M. R.	37	normal	normal	yes
M. A.	36	slight limitation	slight limitat.	no
E. J.	40	normal	normal	no
E. R.	41	slight limitation	normal	no
H. S.	38	normal	normal	no
C. G.	unkn.	unknown	unknown	no
C. I.	unkn.	unknown	unknown	no
D. Z.	unkn.	unknown	unknown	no
M. S.	40	normal	normal	no
S. K.	40	slight limitation	slight limitat.	no

B. II. Disturbances of occlusion

The midline was shifted 4 mm toward the reconstructed side in one 6 year old patient, however facial symmetry and condylar movement were not affected. In addition the mandibular left deciduous central and lateral incisors were separated by 3 mm. In another case the midline was deviated 2 mm towards the reconstructed side. In both cases there was no TMJ pain respectively 3 and 4 years after surgery. In all other cases there was no disturbance of occlusion.

B. III. Masticatory function

In 2 patients with a full natural dentition there were, as expected, no abnormalities in masticatory function following reconstruction of the ramus and condyle only. In 10 other patients, with either mandibular body reconstruction only, or body and ramus reconstruction, where only teeth on the reconstructed side were missing, no disturbances in chewing ability were found. None of these patients wore mandibular prostheses even though conditions were favourable for the wearing of a partial denture. It was also found that the teeth opposing the edentulous area did not over erupt. A total lowering of the floor of the mouth and vestibuloplasty was performed on one patient and a partial lowering of the floor of the mouth and vestibuloplasty in 2 patients (all with free

split-thickness skin grafts). Denture retention was satisfactory in these patients. 2 other patients are presently awaiting total and partial lowering of the floor of the mouth respectively. 3 patients were not available for postoperative follow-up.

B. IV. Sensibility

One patient had normal sensibility in the mental nerve distribution one year after treatment and 12 other patients had hypo-aesthesia after 4 to 14 years. 5 patients had anesthesia and 3 patients from foreign countries, at the time of their last examination from one to 4 years after operation, had no feeling in the corresponding lower lip but were not available for later postoperative examination *(Table 4)*.

Table 4 Results of sensibility tests in the mental nerve area.

Sensibility	Patients	Post-operative examination (years)
Normal	1	1
Hypo-aesthesia	12	4–14
Anesthesia	5 + 3*	1– 4

* The 3 patients from foreign countries had anesthesia at the time of the last clinical evaluation; the present degree of impairment of sensibility is unknown.

B. V. Motor disturbances

In one patient only was a facial weakness noted. The motor function of the marginal branch was partially reduced for a period of 4 months. Complete function then returned.

C. Behaviour of the graft

There is a large loss of volume during the bony remodelling of the free bone graft. The amount of loss cannot be measured exactly radiographically because no reference points were placed on the graft. On the other hand it seems doubtful that radio-opaque reference points could help to evaluate the degree of bone resorption because the metal implants used until now would move in the soft tissues after some resorption of the graft. We estimate the loss of bone to be approximately 40–50%. With the development of a thick cortex after about 6–9 months, the reorganization process appears to be completed.

In one patient, a condyle regenerated on the reconstructed side which can hardly be distinguished from the normal condyle; and the coronoid process, which was severed from the resected bone reunited with the graft. Bone grafts in 4 children, one aged 3, one 6, and two 12 years at the time of operation showed growth 3, 6, 8 and 12 years respectively post-operatively. *Obwegeser* (1966) observed this in one of the above patients. These very interesting findings will be investigated and published separately at a later date, since two of the 4 cases are not yet old enough for final growth evaluation.

D. Complications

The complications are listed in *Table 5*. In one of the 21 patients, the graft had to be removed and reconstructed because of osteomyelitis. Abscess formation occurred at the site of operation twice on the 6th postoperative day and once 5 weeks after the operation. After drainage and antibiotic irrigation the graft healed without further complication. In one other case, a suture dehiscence occurred after the operation, so that 1 cm^2 of iliac bone graft was exposed. This was treated by packing with Vaseline-Aureomycin gauze strips thereby allowing secondary epithelialization and healing. In 3 patients, a pseudarthrosis occurred respectively 2 months, 3 months and 3 years postoperatively. In one of these cases, the graft was completely resorbed within one year. The pseudarthroses were re-operated utilizing rib grafts to bridge the defects. 6 years after a disarticulation and reconstruction operation, in one patient, the initial signs of an ankylosis appeared with a mouth opening decreasing to 32 mm. A type of arthroplasty was performed as mentioned in E.

It may be mentioned, that the postoperative course was without complication in the two cases in which intermaxillary fixation was not possible.

Table 5 Complications of resection and simultaneous reconstruction of parts of the mandible via the oral route in cases not infected primarily.

Loss of graft (osteomyelitis)	1
Infection without loss of graft	3
Pseudarthrosis	3
Commencing ankylosis	1

E. Additional operations

As previously mentioned (B. III.) a total or partial lowering of the floor of the mouth and vestibuloplasty was performed on 3 patients to improve the mouth for prosthodontic treatment. Two other patients are presently awaiting pre-prosthetic surgery.

One patient with symmetrical retrognathia, who was operated on by resection at 15 years of age, had a further operation 4 years later to correct the distocclusion by the sagittal splitting technique. One patient, described in D had an operation to correct an ankylosis that began to appear 6 years after ramus-condyle reconstruction. 3 years after the arthroplasty was performed, the patient can open his mouth 36 mm. Three patients mentioned in D developed a pseudarthrosis. These were all re-operated utilizing rib grafts to bridge the defects. The grafts healed in all cases without complication.

Discussion

The literature which was reviewed did not contain a series with partial resection and simultaneous reconstruction of the mandible via the extraoral approach which presented a similar number of cases as our study. *Conley* (1953) alone describes a series of 12 patients with malignant and 5 with benign tumours. All were treated by resection and simultaneous reconstruction via the extra-oral route. The grafts taken from the iliac crest were fixed by vitallium plates. Only the group of the 5 benign tumours can be compared with our cases. Once the grafted bone had to be partially removed because of infection and another case developed a fistula. In 3 patients the functional result was unsatisfacting.

Gorski (1959) reports 7 cases of partial resection and simultaneous reconstruction of the mandible performed via an external incision. Twice he observed the loss of the transplanted bone; in one of these two cases the author used homogenous bone for reconstruction. A successful procedure for resection and reconstruction in one session using the extra-oral approach is described by *Perko* (1960). Two further cases were described by *Montant* and *Held* (1963) who fixed the graft by Kirschner wires.

Unfortunately detailed data about aesthetic and functional result are missing in the reports mentioned above. In spite of this, from *Conlay's* (1953) and *Gorski's* (1959) material it can be deduced that a similar complication rate is to be expected with extra-oral or combined extra- and intra-oral approach, as we have seen in our series.

Reports on resection and simultaneous reconstruction via the oral route are also very rare. In 1960, *Obwegeser* had already reported the oral approach for resection and simultaneous reconstruction of the mandible. Further reports followed (*Obwegeser* 1963, 1965, 1966). However, he includes in his reports cases with and without preoperative infection. *Heidsiek* (1961) describes 3 cases of intra-oral mandibular resection and simultaneous reconstruction. The grafts healed without complication in 2 cases and in one case healing continued in spite of abscess formation. Two more cases were reported by *Čelešnik* (1963) without postoperative complication. *Nasteff* (1965) also spoke of favourable results, in the immediate intra-oral reconstruction of the resected mandible, without stating the number of cases and eventual complications.

The above mentioned complications as well as those found in our series such as suture dehiscence or abscess formation are not necessarily followed by graft loss. The initial ankylosis observed in our study is possible, in our opinion, in any joint reconstruction, with bone. A possible cause of early pseudarthrosis formation in two of our cases could have been insufficient stabilization, either due to releasing the intermaxillary fixation too soon or inadequate bone fixation. The risk of pseudarthrosis formation between graft and remaining mandible is possible in every case of reconstruction because resorption is involved in the reorganization of the graft and therefore reduced stability of the reconstructed area is present. This was the case in the patient with a pseudarthrosis 3 years after the operation. From our results and from the above mentioned studies, it can be concluded that with antibiotic therapy, infection-free mandibular bone can be replaced via the intra-oral route with autogenous bone material without any major risk. This is fully substantiated by animal research (*Steinhäuser* 1968).

In the Department of Maxillo-Facial Surgery of the University of Zurich, the intra-oral incision is utilized whenever possible, thus eliminating the possibilities of facial nerve damage and extra-

oral scar formation. In patients treated for malignant tumours, who have had radical neck dissection, like *Conley* (1953) we sometimes simultaneously reconstruct the mandible, with rib only, via the extra-oral approach.

Conclusions

The results achieved from intra-oral mandibular resection and simultaneous reconstruction in 21 patients are as follows:

1. The intra-oral route for mandibular surgery can be utilized in an infection-free area.
2. Suture dehiscence and abscess-formation in the field of operation, adequately treated will not cause loss of the graft.
3. During bony reorganization of the graft transplanted to the mandible, there is a loss of bony volume of almost 40–50%.
4. In spite of the resection of the inferior alveolar nerve, there is a partial return of sensibility in the affected lower lip and complete return of sensibility may occur.
5. Both autogenous iliac crest and rib bone appear to be equally satisfactory for reconstruction in our patient material.
6. Free bone grafts in children exhibit growth when normal function is achieved.
7. An excellent TMJ function can be achieved in cases of condylar reconstruction.
8. By utilizing the intra-oral route, rather than to the extra-oral route, damage to the facial nerve and scar formation can be avoided.
9. On the basis of our results, the simultaneous intra-oral resection and reconstruction of the mandible should be the treatment of choice in patients with benign and semi-malignant tumours.

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Hermann F. Sailer, M.D., D.M.D.,
Clinic of Maxillo-Facial Surgery,
Zahnärztliches Institut,
Plattenstraße 11,
CH-8023 Zürich, Switzerland

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