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Experiences with the Use of Lyophilized Bank Cartilage for Facial Contour Correction

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Summary

In the Maxillo-Facial Surgical Clinic in Zurich lyophilized bank cartilage (LBC) is used for facial contour reconstruction and elsewhere. In 122 patients LBC was transplanted 265 times in different sites. The rate of infection was 2.6%, the degree of resorption up to 20%. In 7 cases transplanted LBC was removed for histological examination because of overcorrection. Xeroradiography is suggested as a method of control even when the cartilage is not calcified.

Key-Words: Cartilage transplantation, homologous, lyophilized; Facial contour reconstruction; Histology of LBC; Use of Xeroradiography.

Introduction

In reconstruction of the maxillo-facial area the operating surgeon is frequently confronted with contour defects and dysplasias, which may best be corrected by rebuilding the region concerned. For that purpose, auto-, homo-, heterologous and alloplastic substances are principally used.

The advantages and disadvantages of autologous, heterologous and alloplastic substances are known. Numerous reports concerning the use of homologous, preserved bone and cartilage exist. In the Zurich Clinic lyophilized homologous bank cartilage has been used for 12 years following *Obwegeser's* (1967, 1974) suggestion. The use of cartilage in this preserved form for facial contour reconstruction has not been described in the literature to date. We wish therefore to report our experiences which are as follows.

Surgical Procedure

The lyophilized bank cartilage (LBC) pieces are rehydrated in physiological saline solution with the addition of antibiotics and are then inserted

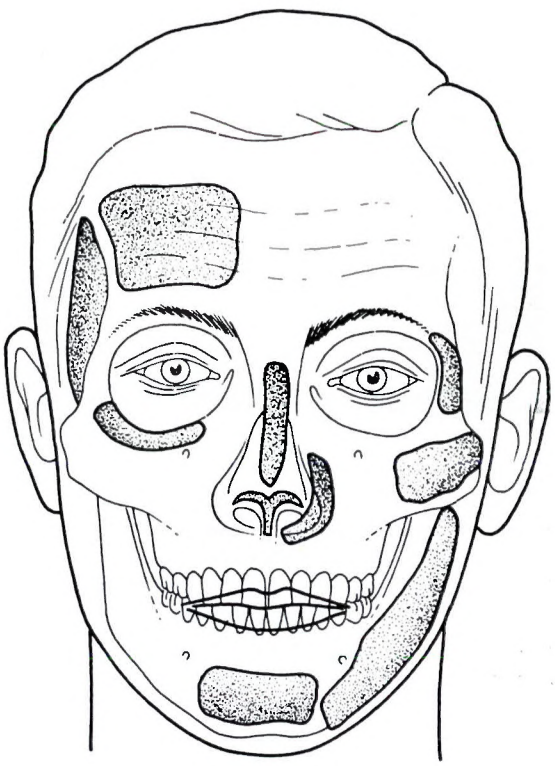


Fig. 1 Sites of facial contours built up with lyophilized bank cartilage.

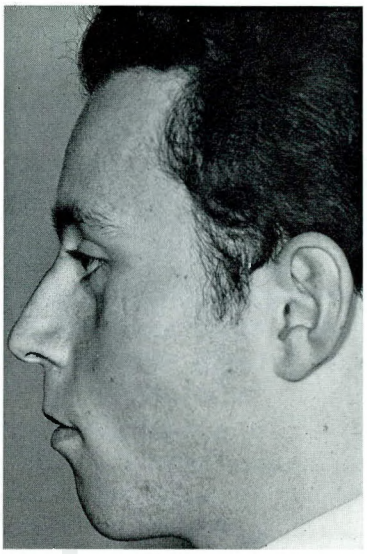


Fig. 2a

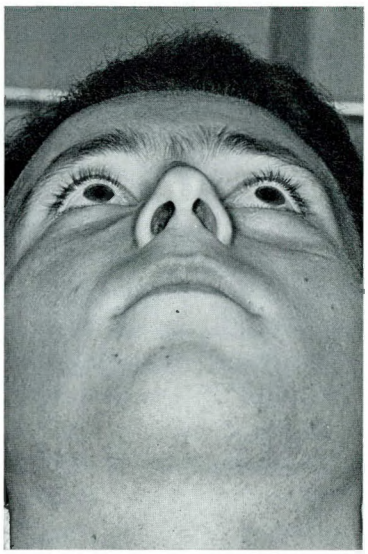


Fig. 2b

Fig. 2a–d
Patient with infra-orbital bony defect after trauma:

a + b) Flattening beneath the left eye.



Fig. 2c

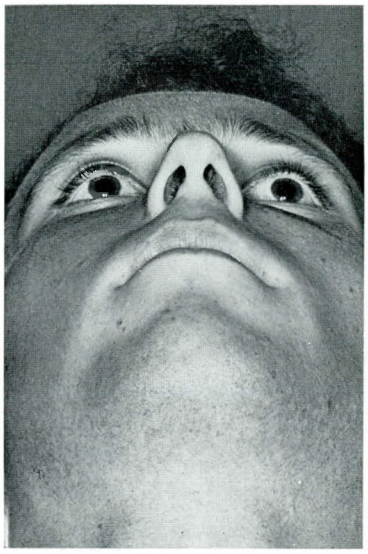


Fig. 2d

c + d) Condition 6 years after rebuilding the infra-orbital area with lyophilized bank cartilage.

subperiosteally in block-form (*Obwegeser* and *Edlan* 1967) or as sliced cartilage, 1/2 to 1 mm in thickness (*Obwegeser* 1974). The slices are cut by hand with a knife or with the help of the dermatome. In certain areas they must be fixed in order to avoid displacement. This can be done with absorbable and non-absorbable sutures, wires or simply by suturing the soft tissues. Whenever possible the oral route is chosen. In order to compensate for resorption slight overcorrection may be made.

Patient Material

From 1962 to mid 1974 265 transplantations of LBC in 122 patients were made in various sites. Antibiotics were generally used with nasal corrections and in other cases only with extensive corrections. The operations refer to the following anatomical regions *(Fig. 1)*:

141 to the area of the piriform aperture in cases of retromaxillism;

49 to the lateral surface of the body, angle and

Fig. 3 a–d
Hypoplasia of the base of the maxilla and mandibular prognathism:

a + b) Full face and profile before operation. Flattening of the region around the piriform aperture and the canine fossa.

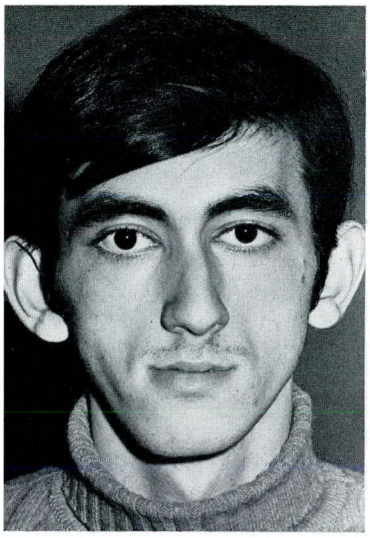


Fig. 3 a

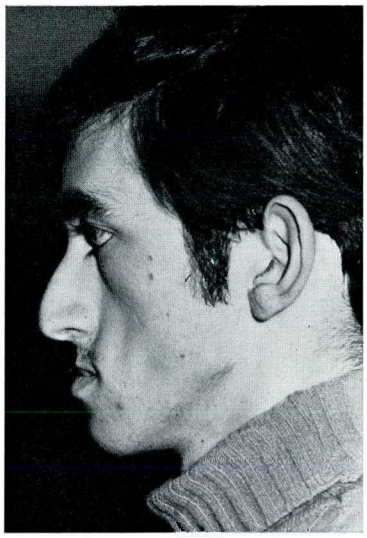


Fig. 3 b

c + d) Condition 2 years after transplantation of lyophilized bank cartilage to canine fossa and around the piriform aperture after repositioning of the lower jaw by using the sagittal split.

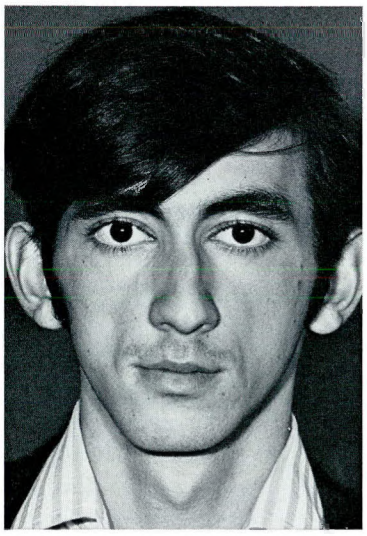


Fig. 3 c

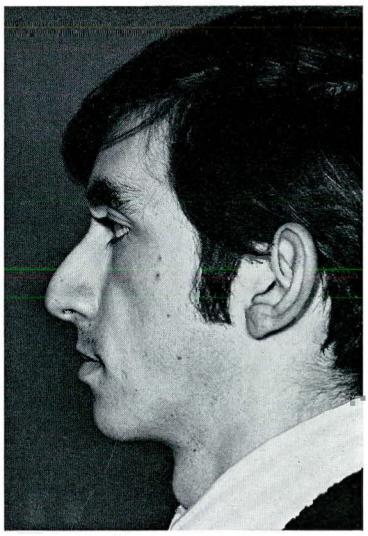


Fig. 3 d

ramus in cases of flattening due to various causes;

24 to the zygoma and zygomatic arch region, especially following post traumatic deformity and malformations;

19 to the columella and nasal bridge with "cleft palate" noses and post traumatic deformities;

15 to the inferior and lateral orbital rim, likewise after trauma and in cases with malformations;

12 to the chin area in the case of a deep labiomental fold;

4 to the temporal fossa in oto-mandibular dysostosis and Rhomberg-syndrome, and

1 to the frontal region in a case of scleroderma.

Results

General Assessment

In 101 patients (83%) the results at follow-up after 1 to 5 years following operation were good:

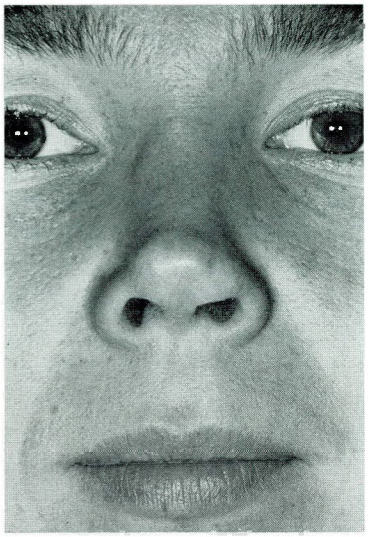


Fig. 4a

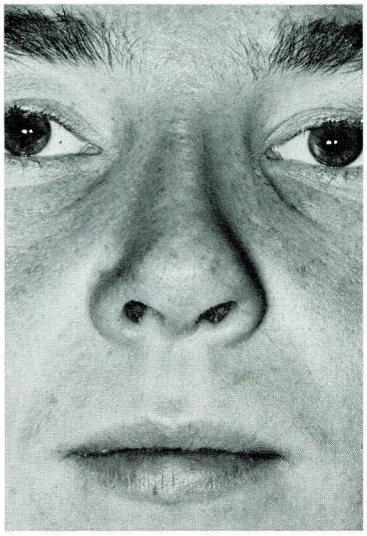


Fig. 4b

Fig. 4a + b
a) Condition after nasal trauma (left).
b) 1 year after putting in a piece of lyophilized bank cartilage (right).

Bank cartilage transplantation does produce a symmetrical contour. Neither the surgeon nor the patient wished for further correction. Some examples are given in *Figs. 2–4.*

Degree of Resorption

The extent of resorption should not be judged merely from the clinical state. It was assessed by means of pre and post operative photographs, by questioning the surgeon and from the operation notes. From this the degree of resorption of LBC is between 10 and 20%. It could be about 10% in the area of the orbital margins, frontal area, the temple, the zygoma and the zygomatic arch and the lateral parts of the mandible, and about 20% in the chin region and around the piriform aperture. In the chin area, the region of the piriform aperture and the lower border of the mandible with only one exception, cartilage blocks were used.

Extent of Primary Healing

More than 97% of all transplants were accepted without reaction. No differences existed between the extraoral and the oral route of insertion.

Clinical Details

The thickness of the largest transplanted cartilage pieces was about 2.5 cm in four cases of oto-mandibular dysostosis. In three of these patients large pieces of block cartilage were used, in one, sliced cartilage. No distortion was observed in the 265 transplants.

Radiological Findings

Calcification was found on conventional radiographs in only 6 out of 265 transplants 1 to 5 years postoperatively.

Without calcification, bank cartilage can only seldom be recognized on radiographs. Sometimes cartilage material transplanted to the lower border or the lateral aspect of the mandible can be visualized by suitable projections. On the other hand it is also possible to identify non-calcified cartilage by means of xeroradiography *(Fig. 5).* Suitable sites for xeroradiography are the lateral and lower part of the mandible, the chin area, the nose, the zygomatic arches, the temporal area and the lateral wall of the orbit. Bank cartilage is rarely visible in the maxilla around the piriform aperture, on the zygoma and below the infraorbital margin.

Complications

The following complications are listed in *Table 1.*

Infection: In 265 transplantations there were 7 infections (2.6%). 4 (1.5%) of the infected transplants were removed, two after nasal corrections. The remaining 3 transplants healed without further complications after local application of

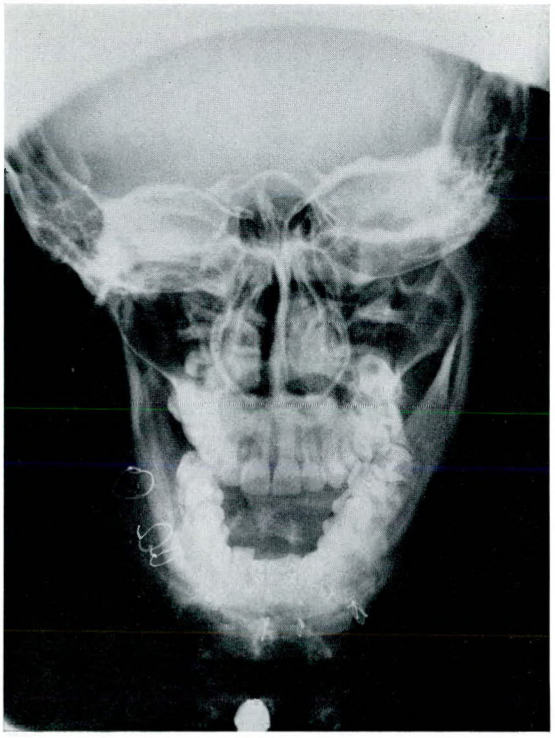


Fig. 5a

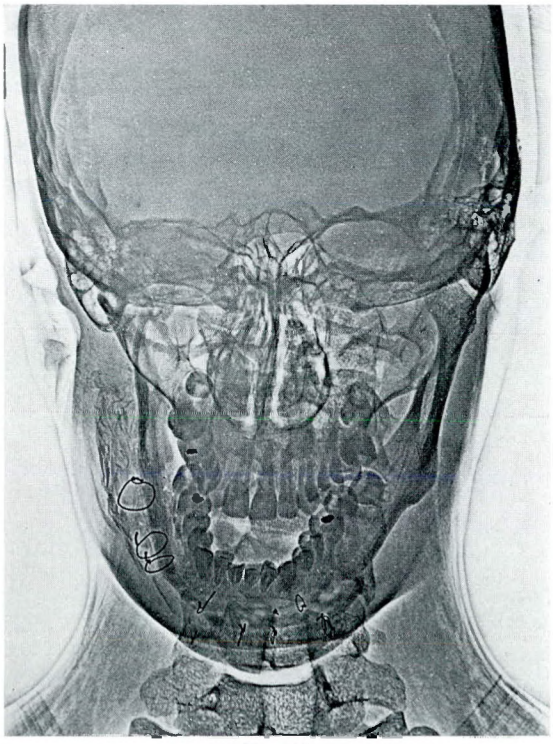


Fig. 5b

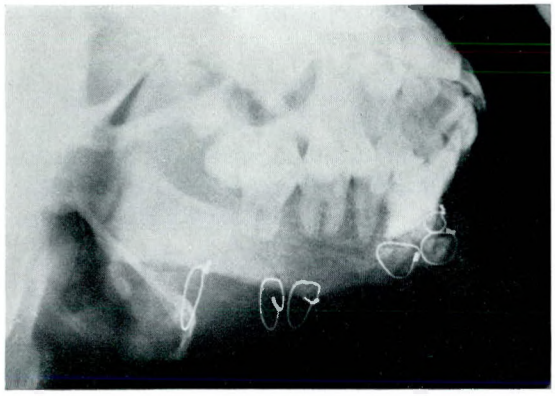


Fig. 5c

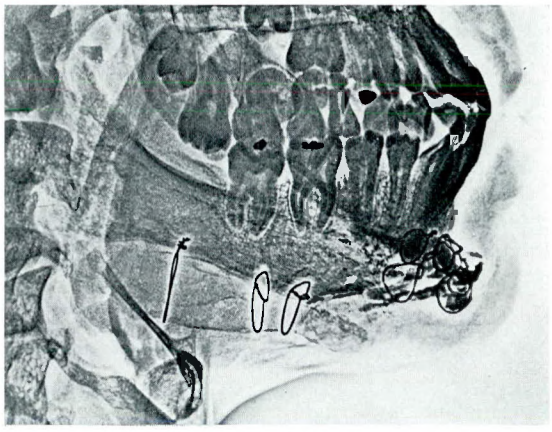


Fig. 5d

Fig. 5a–d Comparison between conventional radiography and xeroradiography: As opposed to conventional radiography (a) bank cartilage transplanted to the lateral surface of the mandible is visible on the xeroradiogram (b) (projection: lower jaw view p.a.). In the conventional radiograph (c) the site of the bank cartilage can be detected only by the fixation wires. In the xeroradiogram (d) bank cartilage, together with soft tissue contours can be clearly recognized (lateral oblique view).

antibiotic solutions (Neomycin) or secondary suturing. Three of the seven infections mentioned above were observed in cases of nasal corrections. All patients with infected transplants had been given antibiotics starting one day before operation.

Under-correction and over-correction: In 6 cases (2.3%) not enough material was transplanted initially. In nine cases (3.4%) an overcorrection had

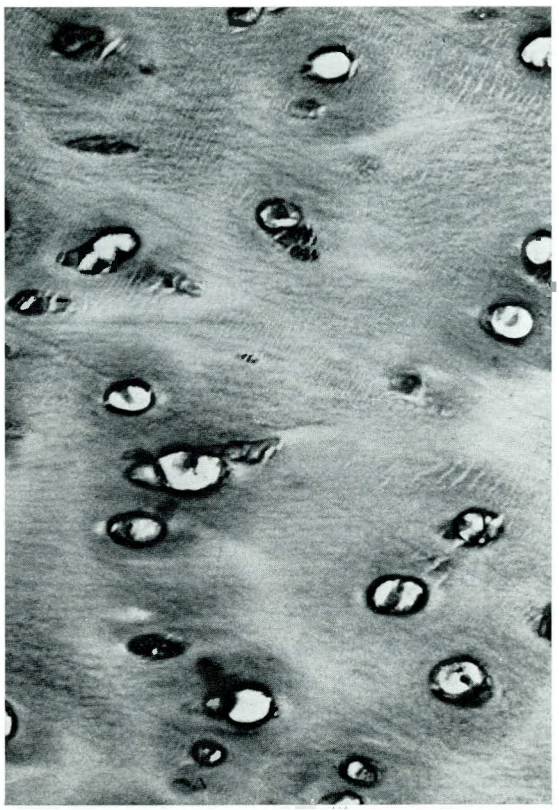


Fig. 6 Fresh rehydrated lyophilized bank cartilage to show staining of nuclear substance in chondrocyte cavities and lack of homogeneity of ground substance (H+E, 400×).

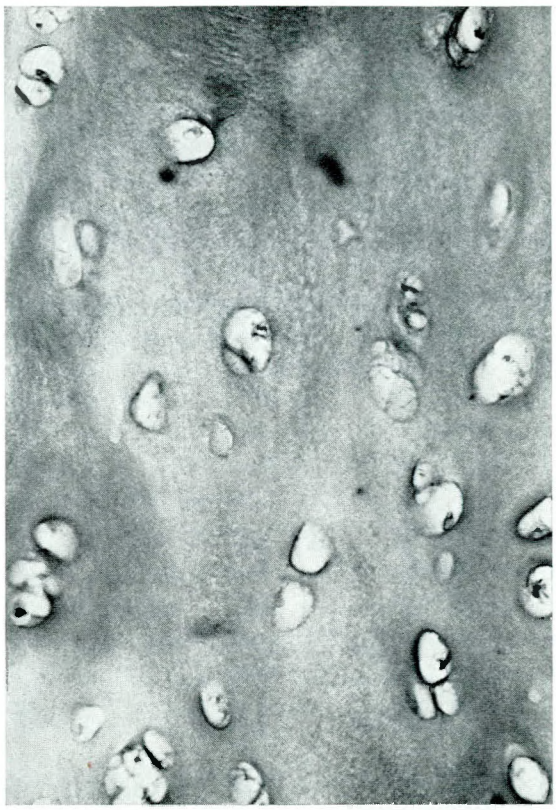


Fig. 7 Lyophilized cartilage, 14 months after transplantation showing collagen fibres and nuclear substance in chondrocyte cavities (H+E,400×).

Table 1 Complications in 265 transplantations.

Infection (Dehiscence, fistula)	7 (2.6%)
Removal of transplant	4 (1.5%)
Undercorrection	6 (2.3%)
Reduction because of permanent overcorrection	9 (3.4%)
Retransplantation because of marked resorption	6 (2.3%)
Dislocation	3 (1.1%)

to be removed 1–2 years post-operatively because of unexpectedly slight resorption. The latter comprised block- and sliced cartilage in approximately equal parts.

Resorption: In 6 patients the resorption was about 40–50%. Another bank cartilage transplantation was then performed, and after 9–17 months follow-up further resorption could not be detected.

Displacement: 3 transplants (1.1%) moved because of insufficient fixation: 2 in the region of the angle of the mandible, one after nasal correction in a patient with a saddle nose.

Histological examination: In 7 cases LBC was removed 3 to 14 months after transplantation and compared microscopically and ultramicroscopically, with a fresh rehydrated specimen. We are grateful to messrs. Dr. *Pfenninger* and Dr. *Spycher* of the Institute for Pathology of the Zurich University, for the results of this examination.

Fresh rehydrated lyophilized cartilage differs in H.E. staining from vital cartilage tissue by a certain lack of homogeneity of staining of the ground substance *(Fig. 6)*. Lyophilized cartilage shows discrete regressive signs *(Fig. 7)* some months after subperiosteal transplantation:

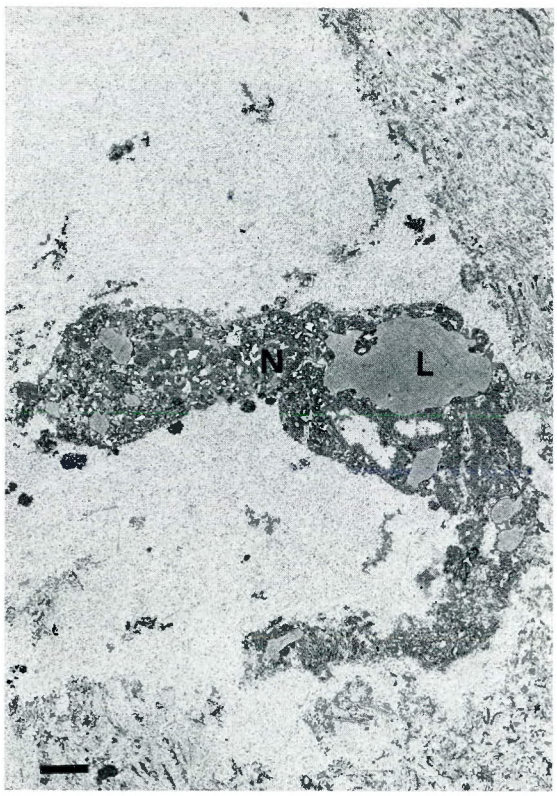


Fig. 8 Low power ultramicroscopy of LBC chondrocyte: the cell and nuclear membranes are partially absent. The clumped nuclear chromatin has lost its strong osmiophilia and its granular appearance (N). Lipid inclusions (L) are present but no organelles are to be seen. OsO_4 – Collodion fixative – Uranylacetate, – leadcitrate stain (Ultramicroscopy, 6000×).

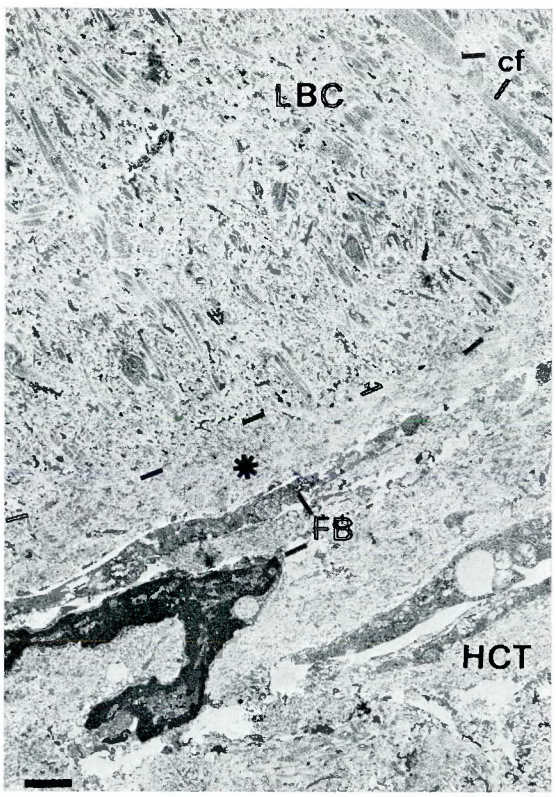


Fig. 9 Low power ultramicroscopy: An intermediate zone (*) exists between the LBC and host connective tissue (HCT) with fibroblasts (FB) containing a small amount of matrix with no large collagen fibres (cf). The edge of the bank cartilage is indicated by an interrupted line. OsO_4 – Collodion fixative – uranylacetate, – leadcitrate stain (Ultramicroscopy, 6000×).

1. Slight basophilic ground substance.
2. Occasional presence of collagen fibres.
3. Discrete signs of fine granular calcification.
4. H.E. stained nuclear substance in the chondrocyte cavities.

From no. 4 we must not conclude that there are normal nuclear structures. The ultra-microscope picture shows that the chondrocytes are destroyed *(Fig. 8)*. On the other hand one recognizes the lack of reaction of the host tissue *(Fig. 9)*. Neither a capsule of connective tissue nor an invasion of fibrous tissue could be demonstrated.

Discussion

The use of homologous preserved cartilage for different reconstructive purposes in the maxillofacial area has often been described. Reaction and use, however, are often judged in a different way. *O'Connor* and *Pierce* (1938) as well as *O'Connor* (1939, 1940) reported good results with homologous cartilage tissue preserved in the refrigerator in merthiolate solution; resorption 6 years after the operation was not reported. These findings were confirmed by *Straith* and *Slaughter* (1941) who performed contour corrections in 100 patients with merthiolate-preserved cartilage: only in 6% of the cases was infection observed; in 5% there was total or partial loss of the transplant. In 398 transplantations with the same type of bank cartilage mentioned above *Rasi* (1959) claimed "twisting" in 6.8% and infection in 4.3%. The degree of resorption was very different: at follow-up examinations of 59 transplantations in 16 cases it

was 55 to 100%. At histological examination *Peer* (1938, 1939) discovered that cartilage transplants preserved in alcohol showed invasion of connective tissue and partial resorption. After 75 cases of nasal correction with rib cartilage preserved in formalin and merthiolate solution *Lamont* (1945) reported that in his opinion there were no essential clinical differences between homologous, preserved and autologous cartilage after transplantation. *Eisenstodt* (1946, 1947, 1953) could neither detect resorption nor infection in 100 cases of chin correction with cartilage preserved in merthiolate solution in spite of not using antibiotics. *Dingman* (1950), however, who reported of resorption, foreign body reactions and extrusion of grafts, had unfavourable experiences with preserved homologous cartilage. On the other hand *Krenar* (1958) reported on the use of refrigerated bank cartilage for purposes of reconstruction in the facial area. In 70% of 30 cases the results were said to be excellent; in 4 patients the transplants were rejected or resorbed within the first year after operation. *Köle* (1962) reported in detail on his experiences with refrigerated bank cartilage in 92 patients. In only 4 cases (4.3%) did a transplant have to be removed because of infection. *Köle* (1962) concluded that homologous deep frozen cartilage was only slightly less well tolerated than the autologous cartilage. Autologous cartilage showed a certain though slight resorption in the first weeks after the transplantation (*Davis* and *Gibson* 1955); the resorption of autologous sliced cartilage grafts, however, can be extensive. *Kilner* (1955) had the impression that autologous cartilage transplants to the infraorbital region tended to resorb.

Zurbuchen et al. (1959) reported on the use of lyophilized homologous bank cartilage for filling intraosseous jaw cysts, in parodontal surgery and for rebuilding of the alveolar ridge.

At the Zurich Clinic LBC is used as a block transplant (*Obwegeser* and *Edlan* 1967) and as sliced transplant (*Obwegeser* 1971, 1974) for the rebuilding of facial contours. In the opinion of *Obwegeser* (personal communication) block cartilage resorbs more than sliced cartilage. When using cartilage blocks an overcorrection of about 20% should be performed. Because of the insignificant resorption of sliced cartilage we have for the last 3 years abandoned over-correction when using this method.

Our researches show the degree of resorption of subperiosteally placed LBC at about 10–20%. According to *Köle* (1967) the extent of resorption using deep frozen homologous bank cartilage is also 20%. LBC, however, is superior to the latter because of its lower rate of infection (2.7%) and rate of loss (1.5%). Our explanation for this is the absorption of antibiotics during rehydration. According to *Pate* and *Sawyer* (1954) the acceptance of tissues dried by freezing depends among others on the loss of antigenicity and electric potentials combined with the process of lyophilization.

Conclusions

1. Lyophilized homologous bank cartilage has proved to be advantageous for the rebuilding of facial contours as a subperiosteal deposit. The infection rate is lower than with other preserved, homologous cartilage transplants mentioned in the literature.
2. The oral route of transplantation does not incur any risk for lyophilized bank cartilage.
3. Lyophilized bank cartilage may be slightly inferior to autologous cartilage material with regard to resorption, but it may well be superior with regard to infection and ease of use. In addition the patient is spared a further operation.
4. Lyophilized bank cartilage is available in practically unlimited quantity and can be kept indefinitely at room temperature, and can be transported without risk.

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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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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-

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

"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

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.

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

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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.