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The Le Fort I osteotomy as a surgical approach for removal of tumours of the midface

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SUMMARY. **Tumours of the midface and maxillary sinuses have been removed via multiple approaches. The most common approaches are those using incisions in the facial skin, especially in the case of malignant tumours. The Le Fort I procedure via an intraoral incision as described by Sailer in 1986 is a versatile alternative. Combined with a coronal approach and various osteotomies of the upper face it also allows removal of tumours extending into the orbits, the nasoethmoidal complex and the skull base. The versatility of the Le Fort I osteotomy as a surgical approach was analysed in 17 cases. This method is reliable and gives excellent access. Further advantages are the wide surgical exposure and the clear visibility of the resection margins, the absence of visible scars, the feasibility of combining this approach with reconstruction using the buccal fat pad and the possibility of simultaneous placement of bone grafts, insertion of endosseous implants or other preprosthetic procedures via the same incision.**

INTRODUCTION

Historical reviews on orthognathic surgery predate the Le Fort I osteotomy in the period 1920–1930 (Cohn-Stock, Wassmund, Axhausen) before Obwegeser made it a standard procedure for surgical correction of dysgnathias and maxillary cleft deformities in the 1960s (*Obwegeser*, 1969; *Steinhäuser*, 1996). However, Le Fort I-like procedures via extensive incisions of the facial soft tissues had already been described in the nineteenth century as a surgical approach for tumour removal. The first descriptions of this type of intervention are attributed to *von Langenbeck* in 1859 and to *Cheever* in 1867, for removal of nasopharyngeal tumours (*Moloney*, 1981; *Drommer*, 1986). Drommer also refers to a quotation by *Lanz* in 1893 about an additional sagittal division of the mobilized maxilla, performed some years earlier by *Kocher* for providing access to the pituitary fossa (*Drommer*, 1986). In 1986, *Sailer* described the use of the above mentioned modern version of the Le Fort I osteotomy as a surgical approach for the removal of pathological conditions within the maxilla (*Sailer* and *Makek*, 1986a). In addition, he described the buccal fat pad flap for reconstruction of the nasal layer covering the bony reconstruction of the maxilla following partial maxillectomy (*Sailer* and *Makek*, 1986b). The 17 cases described in this article illustrate the versatility of this method and its advantages for simultaneous reconstruction.

MATERIAL AND METHODS

A retrospective analysis was performed in 17 cases in which the Le Fort I approach was used for tumour removal, over the last 10 years. The patient group consisted of six male and 11 female patients. The average age was 38 years (range 13–73) and the average follow-up period was 5 years (range 1–10). One patient had been treated by radiotherapy preoperatively (50 Gy) and one patient postoperatively (70 Gy). The following parameters were examined: histopathological diagnosis, localization and extension of the tumours, type of surgical approach, incidence of partial maxillary resection, method of reconstruction, preprosthetic procedure performed, prosthetic rehabilitation and tumour recurrence.

Surgical method

What all cases had in common was that they were at least approached via a Le Fort I osteotomy. This was performed in the standard way as described by *Obwegeser* (*Obwegeser*, 1969). Only the buccal soft tissue incision on the side of the pathology varied. In edentulous jaws, the incision was situated on the alveolar crest. If teeth were present and there was no involvement of the buccal and palatal soft tissues in the pathological process, a marginal incision was made along the buccal and palatal gingival sulcus and papillae of the dentoalveolar segment involved. Anteriorly to this dento-alveolar segment, the incision joined the standard incision line situated 1 cm above the mucogingival junction and, posteriorly, the incision stopped in the cranial direction along the maxillary tuberosity. In ameloblastomas or malignant tumours, the buccal incision line was situated as high in the buccal sulcus as indicated by the resection margins of each tumour. The incision line in the palatal soft tissues was determined in a similar fashion following downfracture of the maxilla with visualization of the contour of the tumour in the maxillary sinus

Table 1 – Histopathological classification of the midface tumours

Benign neoplasms		Semi-malignant		Malignant neoplasms	
Desmo-osteoblastoma	2	Ameloblastoma	2	Metastasis (sarcomatoid renal carcinoma)	1
Osteoma	3	Myxoma	1	Aesthesioneuroblastoma	1
Osseous keloid	3			Lymphoepithelial carcinoma	1
Ossifying fibroma	2				
Aneurysmal bone cyst	1				

Table 2 – Localization and extension of the tumours

Limited to maxillary sinus and its walls, including maxillary alveolar process	10
Extension into orbital walls, pterygoid process, ethmoidal cells and/or sphenoid sinus	5
Invasion from skull base to hard palate	1
Limited to the nasopharynx	1

and/or nasal cavity. If the orbital floor was involved, a transconjunctival approach was used. In the case of tumours extending into the pterygoid fossa, the nasoethmoidal complex or the skull base, this technique was combined with a coronal central or lateral approach (*Obwegeser*, 1985).

RESULTS

The tumours were classified into three groups: benign (11), semi-malignant (3) and malignant (3) (Table 1). All tumours except three were located primarily in the posterior maxilla or the maxillary sinus (Table 2). Ten tumours were located in the maxillary sinus with involvement of neighbouring structures limited to the walls of the maxillary sinus and the underlying maxillary alveolar process. Two cases showed extension of the tumour into the lateral orbital wall and floor, two into the orbital floor, the ethmoid and the sphenoid sinus and one reached from the lateral orbital wall to the sphenoid sinus (Figs 1 and 2). One case (aesthesioneuroblastoma) originated in the olfactory mucosa of the superior nasal cavity and had invaded the cranial base, the orbit and the hard palate. A case of metastasis of a sarcomatoid renal carcinoma was primarily located in the nasoethmoidal complex and had invaded the ipsilateral ortbit and the maxillary sinus. One case was a lymphoepithelial carcinoma situated in the nasopharynx.

The Le Fort I osteotomy was the sole surgical approach in 11 cases (Figs 3 and 4) and was combined with a coronal incision in six cases. Two of the coronal incisions were in conjunction with lateral approaches with temporary osteotomy of the zygomatic complex, one with a central approach via temporary removal of the anterior wall of the frontal sinus and of the nasal bones, and in three cases both a lateral and central approach were used (Table 3). In four cases, a transconjunctival incision was used for exploration or removal and reconstruction of the orbital floor.

Tumour removal was achieved without affecting the anatomical integrity of the maxilla in three cases

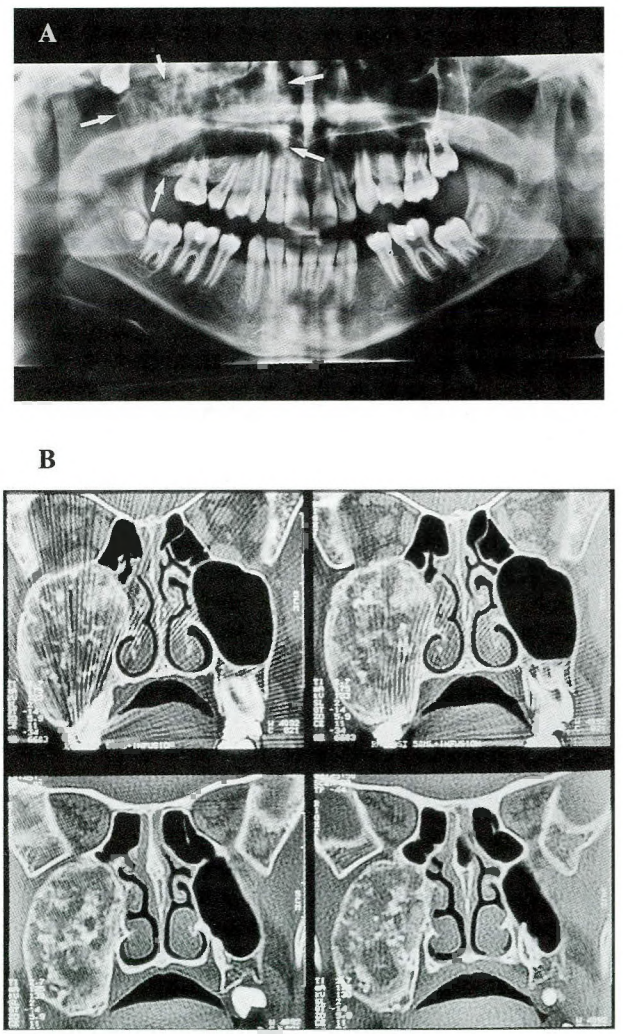


Fig. 1 – (A,B) Preoperative orthopantomogram and coronal CT scan images showing the desmo-osteoblastoma (and the ectopic second molar), situated in the right maxillary sinus and extending into the pterygoid process.

(3/17). In 14 cases, partial removal of the lateral sinus wall, the dento-alveolar process or a combination of both, resulting in a partial maxillectomy, was necessary (Table 4). In three cases (3/14), an obturator was made following temporary packing with gauze held in

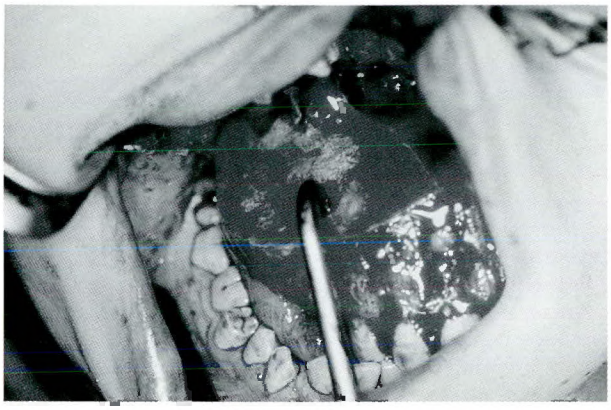


Fig. 3 – Clinical view in the caudal direction of the tumour in the maxilla following Le Fort I osteotomy and mobilization of the maxilla. The partial maxillectomy and ensuing removal of the tumour can be performed under optimal visualization.

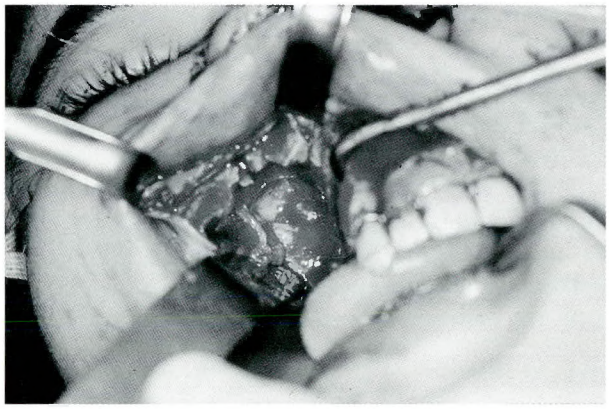


Fig. 4 – Clinical view in the cranial direction following removal of the tumour and the ectopic second molar. Additional mobilization of the maxilla to the contralateral side with a hook increases the surgical exposure of the midface.

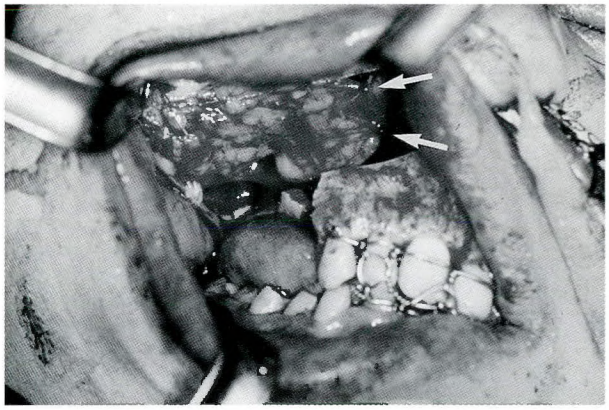


Fig. 5 – Illustration of the mobilized buccal fat pad flap fixed to the nasal mucosa (arrows) for building a nasal layer as the first step of the immediate complete reconstruction after partial maxillectomy.

place by means of a surgical obturator suspended by circumzygomatic wires. In eight cases (8/14), reconstruction was limited to restoration of the skeletal continuity of the lateral antral wall and/or alveolar process with lyophilized bone or cartilage grafts and

Table 3 – List of the surgical approaches

Le Fort I osteotomy	11
Le Fort I osteotomy + upper lateral approach	2
Le Fort I osteotomy + upper central approach	1
Le Fort I osteotomy + upper central and lateral approach	3

Table 4 – Overview of surgical procedures following Le Fort I osteotomy

Repositioning	2
Splitting of the maxilla and repositioning	1
Partial maxillectomy without reconstruction	3
Partial maxillectomy and immediate reconstruction	8
Partial maxillectomy, immediate reconstruction and insertion of implants	3

primary closure of the oral soft tissues. Of these eight cases, four had bone defects extending into the palate. In these cases the lyophilized bone graft was covered with a buccal fat pad flap. Finally, in three cases, complete preprosthetic reconstruction including insertion of endosseous dental implants was carried out (3/14). In two of these with intact sinus mucosa left in the upper part of the maxillary sinus, this consisted of the building of a nasal soft tissue layer, insertion of an autologous bone graft and closure of the oral layer. The nasal soft tissue layer in these cases was created by mobilization of the buccal fat pad which was fixed to the nasal mucosa with resorbable sutures (Fig. 5). Prior to this, a large antrostomy was made in the lateral nasal wall to assure drainage of the residual maxillary sinus. In one case, the tumour (myxoma) had invaded the whole maxillary sinus, so that the remaining mucosa had to be removed. Therefore, the upper part of the sinus was obturated instead with a temporal muscle flap and lyophilized cartilage chips packed in the remaining space on top of it. Following osteosynthesis of the maxilla in its original position, in all three cases endosseous dental implants were inserted ex corpore into a bicortical iliac bone graft between both cortical layers, prior to its insertion into the alveolar defect (Fig. 6) (*Sailer*, 1991). Special care was taken to position the endosseous dental implants in an optimal orientation to the mandibular dentition. The bone graft was shaped such that its borders were in continuity with the contour of the resected alveolar process (Figs 7 and 8). Mobilization of the buccal mucosa allowed primary closure of the oral layer. About 6 months later, a prosthetic device was constructed and functional rehabilitation could be achieved (Figs 9 and 10). In the case of the lymphoepithelial carcinoma, the patient had undergone curative radiotherapy one year preoperatively and presented with suspicion of recurrence. MRI data and endoscopic examination could not exclude this and therefore direct visual inspection of the nasopharyngeal space with the taking of of multiple biopsies was indicated. The inspection was done following mobiliza-

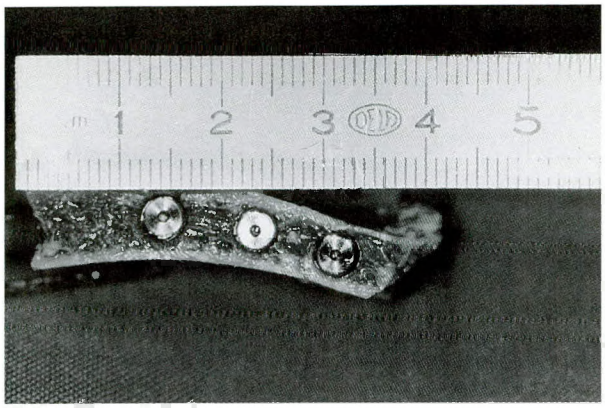


Fig. 6 – The endosseous dental implants are inserted ex corpore between both cortices of a bicortical iliac crest graft.



Fig. 7 – Intraoperative view of the repositioned maxilla, with the reconstructed lateral wall of the maxillary sinus and the new alveolar process with the endosseous dental implants.

tion of the maxilla and removal of the lower half of the vomer, the right inferior concha and the posterior maxillary sinus wall on the right side. Via this approach, the nasopharynx and the right pterygo-palatine fossa were visualized and biopsies taken. Nasal as well as oral endotracheal intubation, which was contraindicated for correct repositioning of the maxilla in intermaxillary fixation, would have reduced

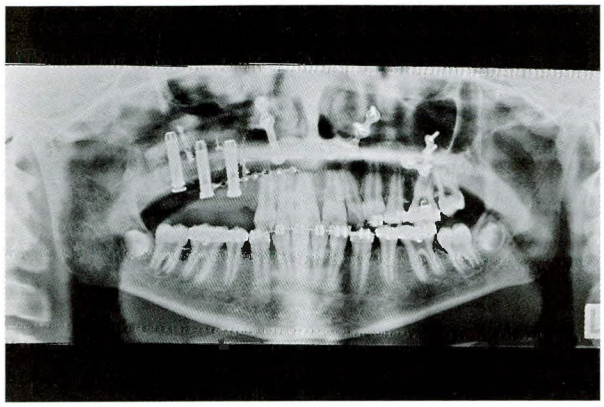


Fig. 8 – Postoperative orthopantomogram illustrating the skeletal reconstruction, the plates used for osteosynthesis of the Le Fort I osteotomy and the implant supported prosthetic device.

the mobility of the maxilla and thus the field of inspection. Therefore, the patient underwent a sub-mandibular intubation, which gives less complications and a less visible scar than is seen after tracheostomy (*Altemir*, 1986b; *Stoll* et al., 1993). Local tumour recurrence, to date, has not occurred, with an average follow-up period of 5 years. In the case of metastasis of sarcomatoid renal carcinoma, multiple metastases developed, also in the face, until the patient died of the disease 6 months postoperatively.

DISCUSSION

The terminology used for the fibro-osteo-cemental lesions involved is the one proposed by *Makek* in 1983. In this classification osseous keloid is a special form of fibrous dysplasia characterized by accelerated bone remodelling and absence of structured lamellae in comparison with fibrous dysplasia, in which the lamellae are curved and regularly distributed. Desmo-osteoblastoma is an aggressive tumour with a high recurrence rate affecting children and adolescents between 5 and 15 years of age. It corresponds to a special form of ossifying fibroma.

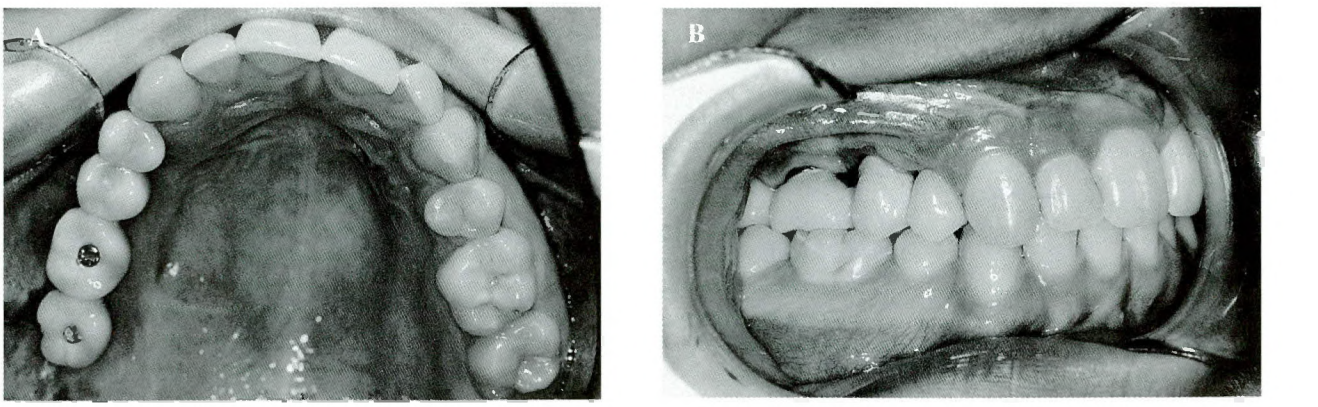


Fig. 9 – (A, B) Clinical views of the prosthetic device and the postoperative occlusion.

Different approaches for removal of tumours in the midface, pterygomaxillary region, skull base and nasopharynx have been described. Most of these use the Ferguson–Weber incision or modifications thereof, giving access to the facial skeleton in order to perform osteotomies or en bloc resections (*Shah and Galicich*, 1977; *Altemir*, 1986a; *Brusati*, 1991; *Salins*, 1997). Alternative incisions are the transfacial incision described by *Curioni* et al. (1984) and Jaeger's jugal extended incision (*Brusati*, 1989).

However, neoplasms of the pterygomaxillary region can as well be approached without producing a visible scar by combining a Le Fort I osteotomy with the lateral approach described by *Obwegeser* (1985). The aesthetic aspect of this approach is not only relevant in younger patients, but is even more important in patients undergoing radiotherapy, in which compromised wound healing can lead to marginal necrosis or dehiscence along the incision line scar. As wide surgical exposure is obtained with this method, the facial incisions cited above are not indicated, unless the skin and underlying soft tissue structures are involved in the pathological process, thus necessitating enbloc resections including the skin.

The Le Fort I osteotomy, as a surgical approach for removal of tumours of the midface, the skull base and the nasopharynx, is part of a more global concept of surgical approaches without a visible incision on the facial skin. Tumours limited to the anterior skull base, the orbits and the nasoethmoidal complex can be removed from the upper central and lateral approaches mentioned, without the need to perform a Le Fort I osteotomy. This approach, however, is needed as soon as the tumour is situated in or extends into the maxillary sinus, the sphenoid sinus or the nasopharynx. All tumours described in this series, except one (nasopharyngeal localization), were either primarily located in the maxillary sinus or had invaded it secondarily. Therefore, the Le Fort I osteotomy was the main approach so that a direct view of both maxillary sinuses and the nasal cavity was possible. The osteotomy cuts in the lateral wall of the maxillary sinus can be adapted to the location of the tumour. High osteotomies situated immediately below or even through the infraorbital foramen allow a direct view of the orbital floor. Via this approach, the inner nasal structures can be removed, thus giving access and a direct view into the ethmoid complex, the sphenoid sinus and the skull base without affecting the integrity of the outer nasal skeleton. Although not necessarily in the series described, the Le Fort I osteotomy can, for reasons of oncological necessity, be combined with a Le Fort III-like design on the involved side, linked along the ipsilateral paranasal rim with the Le Fort I level.

In none of the cases described was there lack of exposure via this approach, which would have necessitated an additional midline lip split, mandibulotomy and glossotomy as advocated by several authors (*Sandor* et al., 1990; *Grime* et al., 1991). The Le Fort I osteotomy was even described as a single access for exposing the medial compartment of the inferior skull base from the tuberculum sellae to the foramen magnum, in order to perform neurosurgical procedures following pharyngotomy, clivectomy and dural opening (*van Loveren* et al., 1994). Other authors reported access difficulties with this type of approach. A unilateral Le Fort I osteotomy was used in the case of an encephalocoele in a cleft patient, but an additional partial Weber–Ferguson incision was necessary to assure sufficient exposure (*Müller* et al., 1981). This might not have been necessary if both maxillary segments had been mobilized. The safe attainment of wide surgical exposure via the Le Fort I approach was also demonstrated in 1989 by *Wood* and *Stell* in five cases of removal of midfacial and skull base tumours. They advocate that, considering the advantages of both wide exposure and absence of facial scars, otolaryngologists and neurosurgeons should appeal to the oral and maxillofacial surgeon for combined specialty treatment of these tumours via this approach (*Wood* and *Stell*, 1989). Another advantage of the Le Fort I approach is the facilitation of the ensuing reconstructive procedures. It allows excellent access to mobilize and fix the buccal fat pad to the medial aspect of the defect following partial maxillary resection in order to cover the nasal aspect of bone grafts in resections involving the whole maxillary sinus floor (*Egyedi*, 1977; *Sailer* and *Makek*, 1986). Adaptation of the bone graft inserted in the bone defects and the ensuing optimal placement of dental endosseous implants can be done via the same incision. In the case with underlying dysgnathia, the intermaxillary relationship can be corrected at the same time, prior to prosthetic rehabilitation. This was done in one of the cases described in which the maxilla was repositioned in an anterior position.

The transoral approach using the Le Fort I osteotomy offers excellent access and facilitates preprosthetic reconstruction without creating aesthetic drawbacks as is seen with transfacial incisions. Its application must not be limited to the removal of benign tumours, on condition that the level of the Le Fort I osteotomy is adapted to the resection borders of the tumour and that additional cranial lateral and central approaches are used if necessary.

Transfacial incisions and approaches should be reserved for underlying malignancies which have invaded the facial soft tissues.

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