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Endoscopic Approaches to Maxillary Orthognathic Surgery

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Endoscopically assisted surgery has become an essential component in many fields of surgical specialties. The implementation of this technique to craniofacial and maxillofacial surgery is a recent development. Endoscopic approach to subcondylar mandible fractures has been established as reliable surgical method [1–4]. The endoscopic repair of midfacial and malar fractures, of traumatic arch injury, of frontal sinus fracture, and of orbital fractures is described in the recent literature also [5–10].

The use of endoscopic techniques in the field of orthognathic surgery must be addressed separately for the sagittal split osteotomy and the Le Fort l osteotomy. Troulis and colleagues [11,12] have described the endoscopic vertical ramus osteotomy followed by rigid fixation for treating mandibular prognathism. There are only a few articles published that present endoscopic approaches to the midface and Le Fort l level with regard to orthognathic surgery [13–15].

What could be the benefit of an endoscopically assisted Le Fort l osteotomy? First, there is need to describe the commonly used technique with an open approach. Through a horizontal incision of the mucosal soft tissue in the Le Fort l plane, the osteotomy is performed using an oscillating saw. The pterygomaxillary junction, the lateral nasal wall, and the nasal septum can be osteotomized using different chisels. The downfracture of the Le Fort l plane completes this procedure after an average operation time of about 30 minutes. In most of the cases, the le Fort I osteotomy as mono-segment or multi-segment procedure is performed to correct congenital and acquired deformities of the jaws. The overall complication rate of Le Fort l osteotomies varies between 6% and 9% [16,17]. Hemorrhage, infection, and maxillary necrosis represent the majority of these complications. Some authors reported ischemic problems because of the decreased vascularization of mostly anterior maxillary segments [18,19]. Different cadaveric studies showed that the commonly performed le Fort l osteotomy carries the risk of injury to the descending palatal artery [20,21]. Only the ascending palatal artery and the pharyngeal branch arising from the ascending pharyngeal artery can be preserved routinely. Quejada and colleagues [22] could show in an animal study that the maintenance of vascular pedicles to the palate and labiobuccal area was sufficient to support total maxillary osteotomy despite trans-section of both descending palatinal vessels. Lanigan and colleagues [23,24], however, suggested total maxillary osteotomy using vertical incisions from the buccal approach with tun-

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Fig. 1. Subperiostal dissection of the lateral buttress.

Fig. 3. Dissection of the nasal floor.

neling as technically difficult and time-consuming, but possible.

Therefore, the use of an endoscopic technique in combination with basic techniques for Le Fort l osteotomies to minimize the access and to optimize the vascularization should be the aim of future treatments. Nevertheless, a well-documented and standardized treatment as the Le Fort l osteotomy should not turn out to be a difficult endoscopic-assisted treatment. This was the reason to initiate and perform a cadaveric study for the endoscopically assisted Le Fort l osteotomy.

Material and methods

Endoscopic equipment

The endoscope used was a 2.7mm diameter, 30-degree angle scope. A video system composed of a camera, light source (Coldlight Fountain, Karl Storz, Germany), camera converter and monitor (Sony Trinitron [Sony], Singapore) was used to project the endoscopic image to a video display (Sony Videocassette Recorder SVT-S3050P).

Surgical technique

Six fresh cadaver specimens were used to perform this study. Two of the cadavers were edentulous; three were partial, and one was completely dentated. Two vertical incisions were done bilaterally between the roots of the second incisors and the canines, starting 1 to 2 mm above the attached gingiva and performed to the depth of the vestibule [Fig. 1]. Using a periosteal elevator, the lateral wall of the maxilla was exposed subperiosteally. The scope could be inserted into the tunnel, and it visualized the lateral buttress [Figs. 2, 3]. A second vertical incision was accomplished between the roots of the first and second molar, again starting 1 to 2 mm above the attached gingiva. This was performed to the depth of the vestibule [Fig. 4]. Visually controlled by the scope, the mucosa was tunneled to the distal portion of the tuberosity and the pterygomaxillary junction using a periosteal elevator. Subperiosteal tunneling with an ele-

Fig. 2. Endoscope and periosteal elevator inserted to the nasal floor through the paranasal vertical incision.

Fig. 4. Identified and intact descending palatal artery.

Fig. 5. Prototype of a reciprocal saw presenting an elongated but thinner shaft (Medicon Company, Tübingen, Germany).

vator connected the two vertical incisions in the anterior maxilla. The dissection then extended into the nasal cavity, lifting the nasal mucosa from the floor of the nose and from the lateral nasal walls up to the inferior turbinate. This dissection was monitored with the scope. The scope inserted into the lateral tunnel could visualize the performance of straight horizontal osteotomy cuts on both sides through the lateral antral wall, extending from the piriform aperture to the pterygomaxillary junction using a 4 mm osteotome with a mallet [Fig. 5]. With the scope inserted into the nasal cavity between nasal mucosa and floor, a horizontal cut through the medial antral wall and nasal septum was made using the 4 mm osteotome also. A curved osteotome inserted through the posterior vertical incision was placed into the pterygomaxillary junction under visual control with the scope. Osteotomy was accomplished when the blade could be palpated on the palatal aspect. The maxilla then was downfractured using finger pressure.

In the first two cadaver dissections, the Le Fort procedure was performed without fixating the osteotomized segment. In cadavers three to six, rigid fixation was accomplished using self-drilling screws and titanium mini-plates (Compact Stardrive 1.5 mm, Mathys Bettlach, Switzerland). The osteotomized segments were fixed first at the nasal buttress using straight five-hole plates. At the lateral buttress, L-plates were used, positioned through the posterior vertical incision under endoscopic visualization through the lateral tunnel. The fixation of the plates was done manually with the self-drilling screws using a screwdriver.

Results

In all six cadavers, the Le Fort l osteotomy could be performed successfully. The downfractured maxilla offered enough space to insert the scope to identify the descending palatal arteries that were intact in all tested specimens. The nasal soft tissue tube was in all cadavers complete and without laceration. The soft tissue bridge on both buccal sides could be preserved. The longitudinal branches of the facial artery within the gingival mucosa were intact. In all the specimens, maxillary movements up to 5 mm in any direction could be accomplished. The plate fixation was performed at the typical locations paranasal and at the lateral buttress under direct view through the vertical incisions on both sides.

Discussion

The Le Fort l osteotomy is a standard technique for corrections of dentofacial deformities. In experienced hands, a mono-segment osteotomy including osteosynthesis lasts on an average 60 minutes. The cadaver dissection could be accomplished between 30 and 45 minutes. One has to consider, however, that permanent bleeding is a major disturbance of visibility in an endoscopic treatment. This could prolongate an endoscopically assisted surgery dramatically. One possible solution could be injection of vasoactive agents preoperatively into the nasal and buccal mucosa to minimize bleeding during the dissection.

Hemorrhage—one of the major problems in the past—now is almost negligible. Improved technical skills, controlled anesthesia in relative hypotension, stable osteosynthesis, and reduced time of surgery led to this positive development. There remains, however, the risk of bleeding resulting from an injury to the maxillary artery or its branches, with the descending palatine artery being the most common source of bleeding. Recent studies showed that the average blood loss stood in correlation to mode of anesthesia, position of the patient, maxillary or bimaxillary osteotomies, and length of operation [25–27].

The cadaveric dissection allowed a controllable dissection of the nasal and buccal mucosa with the use of endoscopic assistance. The limited approaches resulted in more physiological wounds of the buccal mucosa. The vertical direction of the incisions preserved the anastomotic network between branches of the facial artery and branches of the maxillary artery on the gingiva and buccal mucosa. Therefore, one could expect a further decrease in blood loss, which might be one advantage in clinical applications.

An avulsion or interruption of the posterior descending palatal artery during downfracture of the maxillary segment is possible. Osteotomy of the lateral nasal wall using a straight osteotome can disrupt this vessel. The use of the endoscope could visualize the position of the vessel and al-

lowed for precise osteotomy of the lateral nasal wall with controllable preservation of the vessel in this cadaver study. Siebert and colleagues [21] mentioned that in their cadaver study with open Le Fort l procedure, the descending palatine arteries were interrupted in all their specimens.

Another important issue is the postoperative edema and swelling. The horizontal incision applied for the open Le Fort l osteotomy extending from first molar to first molar creates a wound surface that causes postoperative swelling and edema. Limited approaches with controlled elevation and reduced lesion of the periosteum prevent swelling and edema, which will decrease the risk for postoperative infection and accelerate the recovery.

Often when the open Le Fort l technique has been performed, the patient presents a slight soft tissue sagging in the cheek area on both sides. One reason could be the wide elevation of the periosteum at the buccal side. The limited elevation and intact periosteum in the endoscopic technique prevent the soft tissue from slumping and allow for correct reattachment.

The osteotomies could be performed in this study using chisels. During the open Le Fort l procedure, the reciprocal saw was a commonly used instrumentation that allowed for fast and proper osteotomy. Medicon in Tübingen, Germany, has produced a prototype of a reciprocal saw with a slim but elongated shaft that enables a tunneled osteotomy. There is a need to prove such new instruments to evaluate their qualities and benefits for endoscopic techniques. It is essential to value the advantages against the disadvantages.

Limited approach, reduced bleeding, less edema, and shorter time of recovery might be the advantages. Extended time of surgery, disturbed visibility, higher technical challenge, and more expensive costs could be disadvantageous. The use of this technique for the surgically assisted rapid palatal expansion (SARPE) could one of the main indications. Complete osteotomy without downfracture but sagittal split of the maxilla is the condition for a palatal widening using a distracter. The SARPE turns, with help of the endoscopically assisted technique, more and more into an outpatient treatment.

Further experimental work, however, should help to improve the performance of this technique. Finally, only extensive clinical work could prove the feasibility and value of this technique.

Summary

Endoscopically assisted Le Fort l osteotomy could be performed in a cadaver study successfully. The feasibility of this technique, especially the handling with an irrigation/suction system, can be proved only in clinical use. In a first prospective study, patients with the need of SARPE may benefit from this technique. Minimal access, reduced periosteal elevation, and lessened edema could shorten the time of recovery. The introduction of specifically adapted instruments for endoscopic approaches could improve this technique further.

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