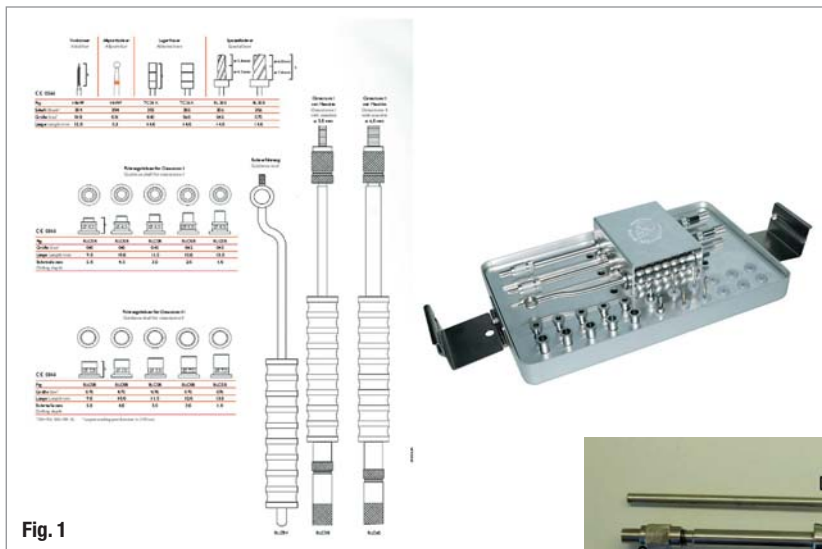


Balloon-Lift-Control (BLC): a minimal-invasive system for the elevation of the sinus floor mucosa

Part 1

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on hand to correct local bone deficiencies and to install a sufficient implant construction.

A special problem of deterioration of the osseous implant layer takes place when the teeth in the side region of the upper jaw are getting lost. Then, atrophy of the alveolar ridge takes place in centrifugal as well as centripetal direction. The result, after a relatively short time, is a maximum loss of vertical height of the alveolar process. The upper jaw side region, however, is of superior importance for dental implantology since it is subject of particularly high axial and lateral stresses.

Basically, the resorbed bone in this area can be fortified with two techniques:
_ First, a buckle—preferably taken from the hip bone—is attached to the alveolar ridge as a so-called onlay-augmentation.

_ Second, the bony sinus floor is strengthened by the insertion of bone construction materials (bone defect fillers, BDF) into a room, which is prepared by elevating the interior lining of the maxillary sinus floor.

Clinically, the latter procedure is used first and foremost.

To begin with, the maxillary sinus lining mucosa—the so-called Schneiderian membrane—must be elevated without a macro- or micro-trauma. Granular augmentation material could penetrate the membrane rupture, and thus arrive at the non-resorptive epithelial layer of the membrane. In the past, two different techniques have been described for access to the maxillary sinus and the elevation of the sinus floor membrane:

Fig. 1 BLC System. Left (from above): Set of different drills and distance tubes. Middle (from left): Lunette (distance tube guide) and two osteotome instruments with apical diameters 3.8 and 6 mm. Right: Surgical tray containing the instruments (drafted on the left hand side).

Fig. 2 Components of an osteotome: Guidance instrument (a) with ergonomic handle (b) and adaptive apex (c). Above it the “mandrin” consisting of a bar (d); literally the osteotome) and an adjustable handle (given in more detail in Fig. 4). The mandrin fits into the tube of the guidance instrument.

Fig. 3 Apex of the osteotome: (b) Shaft with its (b) intraosseous tip (graduated in mm). (c) Security screw (to support the instrument by screwing it to gingiva level when the instrument is inserted into the osseous bore hole).

Within the last 30 years implantology has become more and more a standard treatment in daily dental practices. Endosteal implants have proved to be not only the basis of tightly fixed dentures, they obviously are capable, but also to prevent alveolar bone resorption. The materials, shapes and macro- as well as micro-designs of surface structures were the subject of a constant process of further development.

Also, surgical techniques were created and published to improve the quality and quantity of the bony recipient layer. These advancements are proven in that in former days implants had to follow the available target layer in size and shape while nowadays we obviously have the materials and techniques

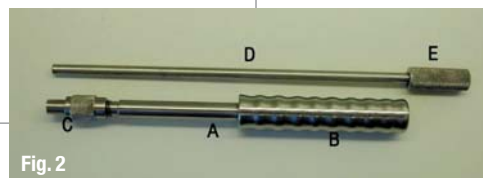


Fig. 2



Fig. 3

– The direct sinus-lift.¹⁰ A bone window (the so-called Tatum window) is milled into the vestibular wall of the maxillary sinus and the window, together with the attached sinus membrane, is separated from the neighbouring bone with special sharp instruments. This method is also called the "open sinus-lift".

– The indirect sinus-lift. The alveolar ridge, together with the sinus membrane, is pushed forward into the sinus by the use of an osteotome. This technique, the "osteotome sinus floor elevation" (OSFE), was first described by Summers.⁹ The OSFE recently has also been referred to as a "closed sinus-lift".

At first glance, both techniques have their pros and cons.

– Advantages of open sinus-lift

- The operation site can easily be studied with the naked eye.
- The sinus membrane can be elevated without restriction.
- Unevenness of the sinus floor (eg, Underwood septa) as well as ruptures of the Schneiderian membrane during the elevation can be recognized and taken into consideration.
- Easy control of bone graft placement is possible.

– Disadvantages of open sinus lift

- The operation lasts considerably longer combined with the extended trauma of soft and hard tissue.
- Thus, the longer exposition of the wound bears a higher risk of bacterial and viral contaminations.
- Expanded postoperative swelling and high levels of pain are inevitable.
- Advantages of closed sinus-lift.
- The operation is minimal invasive.
- The operation usually is of shorter duration.
- The danger of contamination and the postoperative complaints are less likely.

– Disadvantages of closed sinus-lift

- The operation site can only be controlled by using a sinus endoscope.
- Ruptures of the Schneiderian membrane can only be detected indirectly by means of the Valsalva manoeuvre (nose blowing test).
- This technique is significantly limited because the

sinus membrane, in order to remain on the safe side, can only be raised by approximately 3 mm at the maximum (recommendation of Summers⁹).

– The repeated beats on the osteotome are a very unpleasant experience for the patient due to the

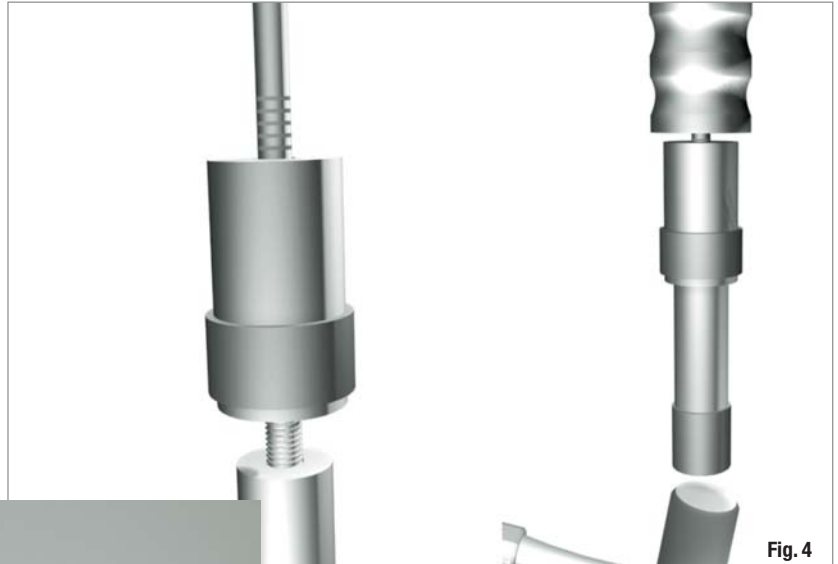


Fig. 4

anatomical proximity to the central and anterior ear.

– Several patients undergoing the indirect elevation procedure suffered from disturbances of equilibrium postoperatively.

Common for both methods is that the Schneiderian membrane is elevated by

Fig. 4 Adjustable handle of the mandrin. Left: Screw to determine its overtopping length when totally inserted in the tube of the guidance instrument. Right: Mandrin inserted into the tube of the guidance instrument; when introduced into the osseous bore hole the apical protrusion of the mandrin (in the range of 1 to 2 mm) is achieved by two to three mild beats upon the mandrin grip, thus infracturing the residual bone into the sinus.



Fig. 5



Fig. 6

use of rigid and sharp instruments. These are the problems of the "classical" sinus-lift:

- The above mentioned Underwood septa, which often come across and run through the whole sinus medio-laterally, represent a reasonable obstacle when applying the open sinus-lift during the preparation of the sinus membrane. Regularly, a major rupture of the sinus membrane at the ridge of the septum takes place.
- The closed sinus-lift includes the danger of a perforation of the Schneiderian membrane by the osteotome itself or by a bone fragment pushed forward by more than 3–4 mm in order to avoid provoking large pointed loads on the sinus membrane.

More than 15 years ago we discussed the possibility of employing a balloon to elevate the sinus membrane. This technique is, in particular (in the form of skin expansion) already in long-time use by

Fig. 5 Balloon catheter connected via Luer-lock and valve to a syringe (f). The syringe, filled with fluidity (either saline or a radio-opaque solution) serves to ventilate the double channel-catheter and to block up the balloon in situ. The free Luer-lock (with valve) connection is designed to ventilate the catheter and to attach a pressure monitoring system (strain gauge).

Fig. 6 Tip of the osteotome instrument (b). The mandrin is replaced by the balloon catheter. (a) The over-looking balloon is insufflated.

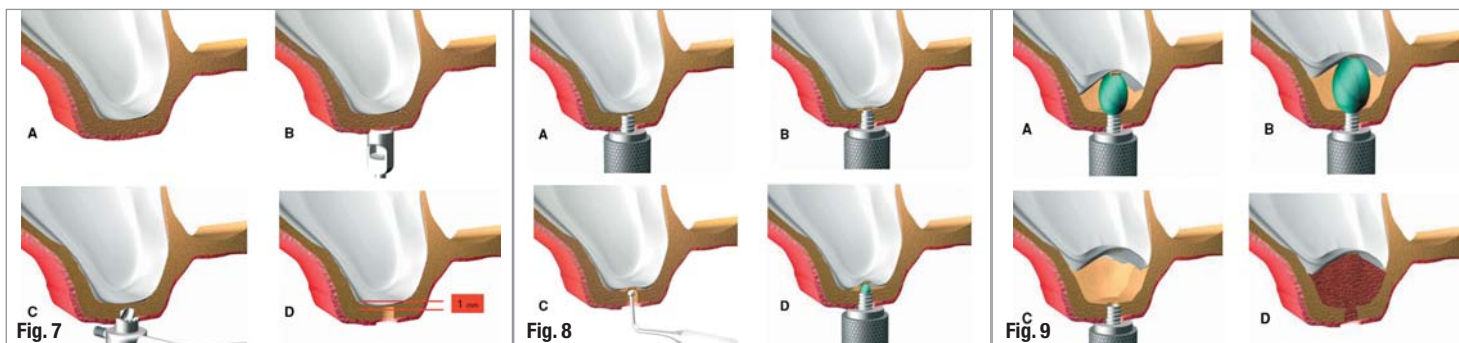


Fig. 7 Procedure of balloon-assisted sinus-mucosa-lift (schematic drawing showing a frontal cut through the distal region of the maxillary sinus with resorbed alveolar process). (a) Initial situation. (b) Removal of the attached gingiva using a punch. (c) Inception of the distance tube (tied into the lunette) and milling the alveolar process to a residual thickness of around 1 mm (d).

Fig. 8 Procedure of balloon-assisted sinus-mucosa-lift (same view as in Fig. 7). (a) Insertion of the osteotome instrument into the osseous bore hole and fitting the security screw to gingiva level. (b) Impressing the residual sinus floor bone (with Schneiderian membrane) approx. 1 mm into the sinus. (c) Mobility test (very necessary) of infracturized bone (and membrane). With a positive result the osteotome is reinserted, the mandrin replaced by the ventilated balloon-catheter.

Fig. 9 Procedure of balloon-assisted sinus-mucosa-lift (same view as in Figs. 7, 8). (a) and (b): Repeated blocking-up of the balloon is necessary to separate the Schneiderian membrane from the sinus floor. (c) The fluidity should discretely be pressed into the balloon (at least 5 times) with increasing volume (up to a maximum of 2 cc; the relation between balloon filling volume and extent of mucosa elevation is given in the text). (d) Situation after filling the submucosal space with appropriate bone defect fillers.

dermatologists to gain reserve cutis in anticipation to cover larger defects of the integument. Our first "in vitro" experiments with the balloon-assisted technique were performed in 1996 on human cadavers (head preparations) using PVC-tubes, on one side of which a condom had been tightly glued. These studies⁶ showed that the formaldehyde-fixed Schneiderian membrane could be lifted from the bone much more homogenous than with a sharp instrument (eg, a new scalpel or brand new "elevators" currently available on the market).

Together with the Rüschi Company (manufacturer of the balloon catheter; Willy Rüschi GmbH, Willy-Rüschi-Straße 4-19; FRG - 71394 Kernen) and the Hager & Meisinger Company (producer of the instrumentation set; Hansemannstr. 10, FRG - 41468 Neuss), the Balloon-Lift-Control System was designed and produced step-by-step.

This paper presents the BLC System and its application on the basis of pre-clinical results and a typical case report.

Material & methods

The BLC System (the operation set and surgical tray are depicted in Fig. 1) primarily consists of three components (Figs. 2-6),

1. a guidance instrument (A; Fig. 2) with an ergonomic handle (B) and an adaptive apex (C),
2. a mandrin (D) (literally, the osteotome) with an adjustable handle (E, Fig. 2), and
3. a balloon catheter (Fig. 5).

The guidance instrument uses a special apical design (Fig. 3). The shaft (B) terminates in an intraosseous tip (b, with a distance graduation in mm). The security or distance screw (C) is designed to underpin the instrument with the gingiva.

The adaptive apex of the guidance instrument permits optimal positioning of the BLC System in the bore hole of the alveolar ridge. This instrument serves as the guider and protection channel for the mandrin as well as the balloon catheter.

The mandrin (literally the osteotome of the BLC System) has a special adjustment system on its handle (Fig. 4) with which the tip surpassing the apex of the guidance instrument (ie, the penetration depth

of the mandrin into the sinus in situ) can be adjusted. In Figure 3, the tip of the mandrin (D) extends 1 mm over the guidance instrument.

The balloon catheter (Fig. 5) consists of a double-channel PVC catheter. Proximally, a latex balloon (max. filling volume 3 cc) is tightly fixed. Distally, the catheter is connected with two Luer-lock connections, each one closable by a valve. Thus it is possible to prefill and ventilate the system with an incompressible fluidity.

Especially for the beginner it is recommended to use a radio-opaque solution (eg, Ultravist® 240, Schering AG, FRG, Berlin) as ventilation and blocking-up fluidity. However, since this marker fluid (usually employed for angiography) contains iodine, one must query the patient about earlier immunological hyperreactions against this substance or thyroid gland dysfunctions.

Figure 6 shows the apical part of the guidance instrument; the mandrin is replaced by a balloon catheter and the balloon is inflated.

Basic application of the BLC System

In Figures 7 to 9 the typical use of the BLC System is depicted step-by-step in schematic drawings.

In Figure 7a the initial situation is presented: frontal cut through the right corpus maxillae. The floor of the maxillary sinus comes down into the alveolar process (forming a subantral space by centrifugal resorption); simultaneously and due to the loss of the molars, the alveolar ridge is reduced (by centripetal resorption). Both processes have resulted in a significant reduction of vertical bone height.

Figure 7b shows the removal of the attached gingiva. The mucosa is drilled up to the compacta of the sinus floor by means of a twist or a trephine drill, whose external diameter corresponds to that of the implant to be inserted. The mucosa punch is kept in a sterile compress soaked with physiological saline for the ex vivo preservation of its vitality.

In Figure 7c the lunette or distance tube guide armed with a distance tube is positioned to the denuded bone and an appropriate drill reduces the alveolar ridge to a remaining bone height of ap-

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proximately 1 mm (Fig. 7d). The bone chips obtained by the milling should be kept in a sterile moist chamber to be added later to the augmentation material.

The distance tube and drill in Figure 8a have been replaced by the osteotome guidance instrument, the security (distance) screw of which has been screwed to gingiva level. Thus the guidance instrument is protected against involuntary penetration into the maxillary sinus. Figure 8b gives the impression of the remaining bone by the tip of the mandrin, to the handle of which two soft beats had been performed.

In Figure 8c, a very necessary procedure in this phase of balloon-assisted sinus lift is presented: the mobility test of the fractured bone (with the attached sinus mucosa) using a probe. If the remaining bone is still immovable, a second impression procedure with a mandrin extending over the tip of the guidance instrument more than 1 mm should be attempted. Again, most important is that the impressed bone and the attached membrane are freely movable.

If this is true the osteotome guidance instrument is reinserted into the bore hole and the mandrin is replaced by the ventilated balloon catheter. Figure 8d gives the first blocking-up procedure of the balloon. In this phase the resistance against the blocking-up is relatively high (preliminary experiments indicate that the pressure necessary to, (a) unfold the balloon and, (b) separate the Schneiderian membrane from the adjacent bone (initially amounts to more than 600 mm Hg).

Figure 9a and 9b show that the balloon in situ has to be blocked-up repeatedly (approx. 5 times), each time with increasing volume. The elasticity of the resistance system (balloon plus Schneiderian membrane) brings about that the piston of the syringe is pushed back after each blocking-up-procedure. In Figure 9 (a-c) it can be recognized that the space gained by the blocking-up of the balloon significantly is higher (around 20%) than the balloon-volume itself. After the removal of the BLCsystem the newly created space under the Schneiderian membrane is subsequently filled up with the augmentation material through the borehole (Fig. 9d). Finally the mucous punch is replaced and fixed with a button suture.

All surgical treatments with the patient were executed under local anaesthesia (Ultracain DS forte; Aventis, FRG, München GmbH). The patient was informed about the operation procedure and the complications one week in advance with special reference to the clinical problems of using an iodine substance as the contrast medium. A mix of β -tricalciumphosphate (Cerasorb®) with autogenous bone (from the milling) and autogenous venous blood was accepted by the patient as augmentation material.

This article is to be continued in issue 2/2207 of implants, international magazine of oral implantology.

The literature list can be requested from the author.



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