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Low Window Technique: A Technical Note

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Abstract

This article describes a technique for performing lateral antrostomy when performing lateral sinus augmentation using a rational approach. Based on a CBCT scan, a surgical guide is designed and manufactured to allow the surgeon to draw the antrostomy flush with the anterior sinus wall and floor, with its height not exceeding 6 mm. The distal antrostomy line is placed in relation to the position of the most distal fixture. This technique facilitates sinus membrane detachment and reduces flap elevation to approximately 10 mm, and potentially prevents intraoperative and postoperative complications saving the patient from later discomfort. The technique is easily reproducible and because it involves a series of standardized steps, it reduces the likelihood of intraoperative errors.

Keywords: Lateral approach; CAD-CAM surgical technique; Membrane perforation; Guided surgery

Introduction

In lateral sinus augmentation, the design and position of the antrostomy determine the degree of elevation of the mucoperiosteal flap, and the width, height, shape, and distance of the window from the sinus floor may restrict the angles at which sinus membrane elevation instruments must operate in order to separate the membrane from the sinus floor. This may affect the likelihood of membrane perforation, the most common complication of sinus augmentation [1-6]. Currently, the position of the window seems to be chosen by surgeons mainly on the basis of personal habits [7-16]. Some authors suggest placing the inferior antrostomy line flush with the sinus floor, others prefer a position up to 2-3 mm higher, as in Simplified Antrostomy Design (S.A.D.), a planned fenestration technique that starts at the medial sinus wall and extends distally 3 mm above the sinus floor [10-17]. Standardized approaches to window preparation should be preferred because they entail fewer surgical errors, a faster learning curve, and greater reproducibility. To this end, based on rational considerations and observations, the authors have recently proposed a technique for designing the lateral window and performing window antrostomy that takes advantage of the tremendous accuracy that can be achieved with modern CAD-CAM fabrication systems. The purpose of this article is to describe this technique, termed the Low Window Sinus Lift [18,19], taking a rational approach to the steps involved.

Surgical Technique

The Low Window designs

In the Low Window antrostomy design, the window is positioned as low and mesial as possible (Figure 1). The inferior osteotomy line is always placed flush with the sinus floor and the mesial line is always flush with the anterior sinus wall. In addition, the height of the window never exceeds 6 mm to avoid intraosseous anastomosis. The distal osteotomy is positioned to correspond to the most distally planned implant. The reason for creating a low window in as coronal and mesial a position as possible is that the more apical and distal the window, the more difficult the surgical access to the sinus. Additionally, the position of this osteotomy design provides specific surgical advantages. Placement of the lower horizontal osteotomy flush with the sinus floor eliminates any residual bone wall that could hinder detachment of the sinus membrane. The position of the distal osteotomy line is optimized according to the position of the most distal implant; extending it more distally provides no advantage and may result in elevation of a wider mucoperiosteal flap.

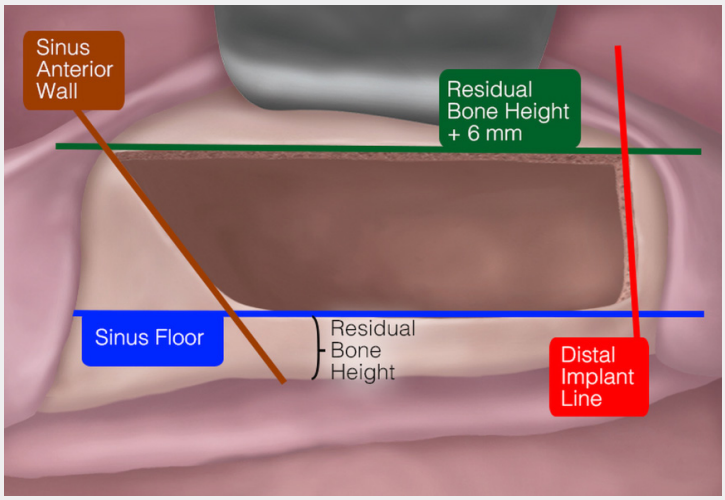

Figure 1: The Low Window Sinus Lift Antrostomy. The inferior osteotomy line (blue) is positioned flush with the sinus floor. The superior (green) is 6 mm higher, i.e., it is placed at a distance from the crest equal to the residual bone height plus 6 mm. The mesial line (brown) is flush with the anterior sinus wall. The distal line (red) should be placed to correspond to the position of the most distal implant.

Placing it more distally forces the surgeon to detach a portion of the membrane in a "blind" condition, with no reference points. The position of the mesial osteotomy line, flush with the anterior sinus wall, allows easier access to the anterior sinus recess, i.e. the zone where detaching the sinus membrane is usually most difficult. A window height of 6 mm is the minimum that allows easy access to membrane elevators. A lower height would be an obstacle to membrane elevation, while a greater height would not confer any appreciable advantage but would require the elevation of a wider mucoperiosteal flap [16]. Low Window design may also reduce the risk of sinus membrane perforation when the A and D angles of the patient's sinus are narrow (i.e., when A < 30°, a condition with increased risk of membrane tearing during detachment [5]). In fact, because the inferior osteotomy line is placed flush with the sinus floor, the modified surgical ALW and DLW approach angles will always be larger than their corresponding anatomic A and D counterparts (Figure 2), reducing the risk of membrane perforation.

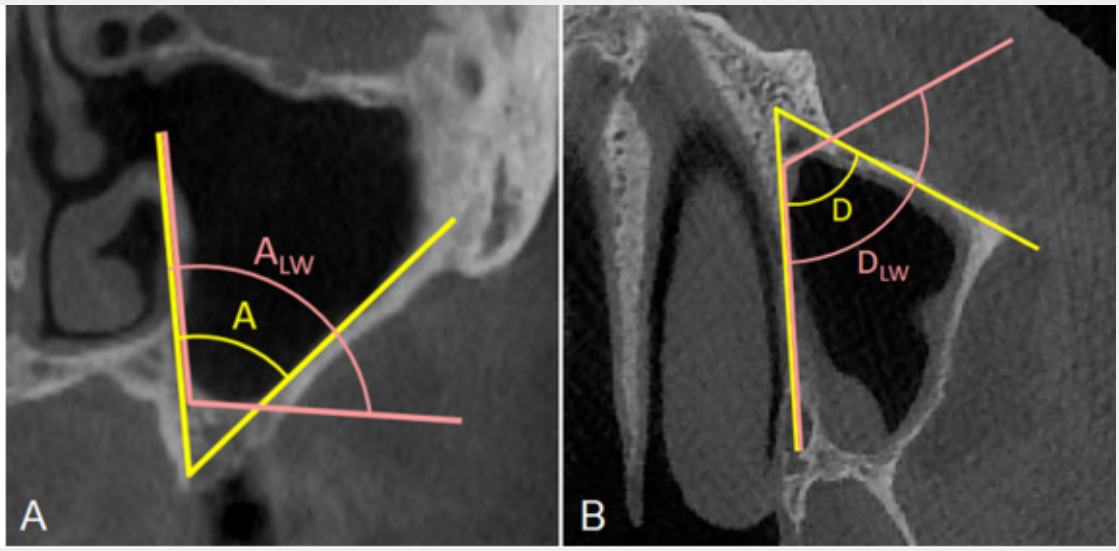

Figure 2: (a) Because in the Low Window antrostomy design the lower osteotomy line is always placed flush with the sinus floor, the surgical angle when approaching the sinus membrane to detach it (ALW) is always independent of the anatomic angle (A). Even if the A angle was < 30°, the ALW angle would still be > 90°. (b) Similarly, in the coronal plane, since the mesial osteotomy line is always flush with the anterior sinus wall, the surgical angle DLW will always be greater than angle D, thereby facilitating elevation of the sinus membrane.

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Designing and manufacturing the surgical guide

Based on a CT or a CBCT scan, the surgeon first plans the implant positions using guided surgery software (Figure 3) and then reads the .STL file corresponding to the maxilla and maxillary sinuses to visualize their anatomy. Using the same software, the surgeon then draws the window according to the Low Window design (Figure 4). Finally, to design the surgical guide, a "raw". STL object is superimposed to the alveolar process and its portion corresponding to the Low Window antrostomy removed (Figure 5). The .STL file of the guide is then 3D-printed to manufacture the surgical guide.

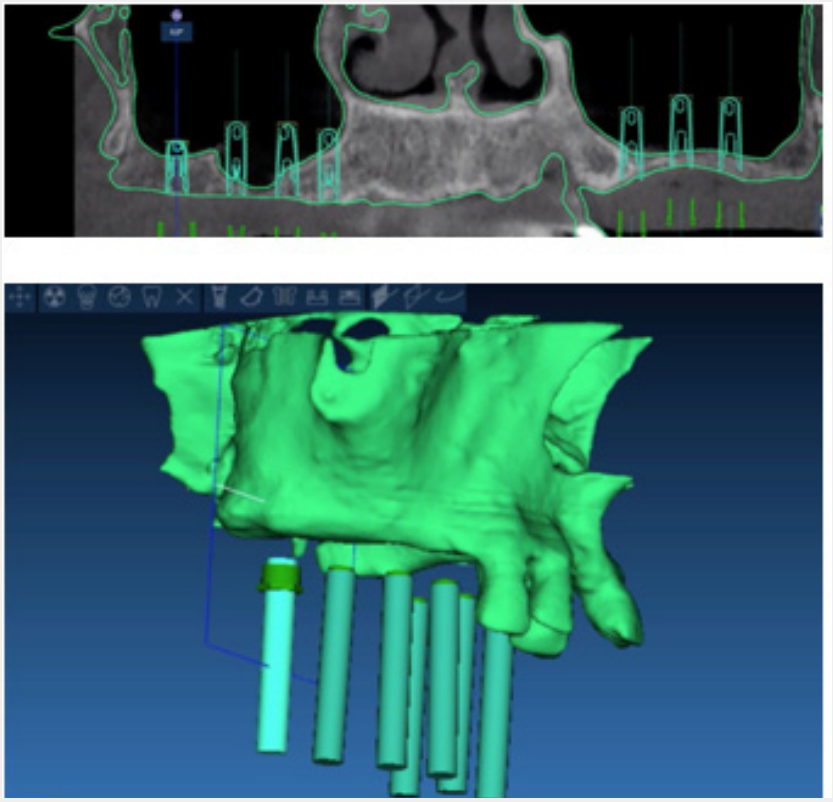

Figure 3: When implants are placed simultaneously with sinus augmentation, the surgeon first plans the implant positions using appropriate guided surgery software.

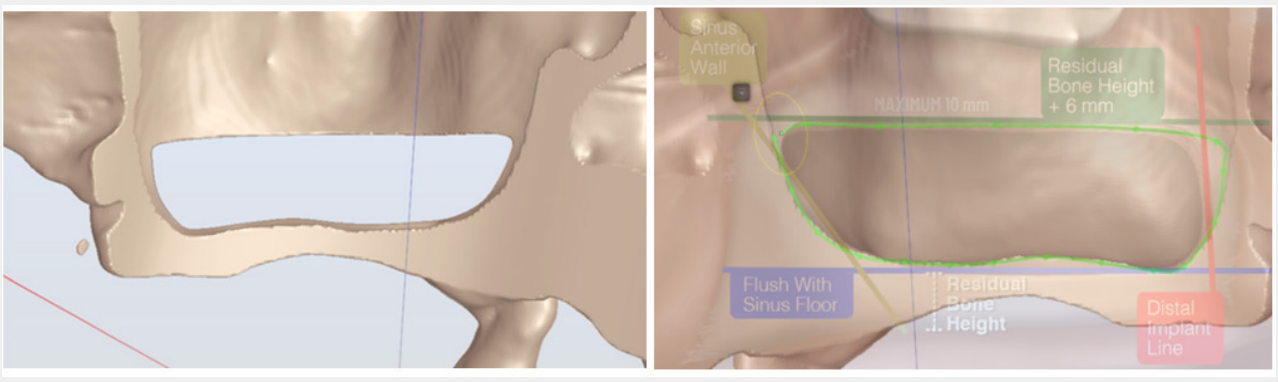

Figure 4: The .STL files for the maxilla are read in to visualize the anatomy of the maxillary sinus. To draw the antrostomy window according to the low-window design, the sinus is virtually divided along the alveolar ridge line, its vestibular part is isolated and visualized from the interior of the sinus. Adherence to the low-window design can be verified by superimposing it on the design shown in Figure 1.

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Surgical steps

The patient is anesthetized locally according to standard protocols. Given the advanced and low position of the antrostomy, tissue retraction is achieved using a flexible aid (Optragate, Ivoclar Vivadent AG, Schaan, Liechtenstein). Its size is chosen according to the size of the patient's mouth. This usually eliminates the need for the dental assistant to pull back the patient's cheeks and lips. The incision lines are drawn using a dermographic pen. The crestal line is medial to the ridge, with no release incisions. It should be moved 1-2 mm more palatal if the buccal attached gingiva is minimal. If a residual distal tooth is present, a paramarginal line is drawn at 3-4 mm at least from the marginal gingiva, starting from its distal papilla. The attached gingiva is incised along the crestal line. A full-thickness incision is performed, going from the distal aspect of the most distal residual tooth to the tuberosity. The incision at the most distal residual tooth is a full-thickness one, up to its mesial aspect, and preserves the papilla. The flap is raised from mesial to distal, not more than 10 mm, leaving intact the attached gingiva at the most distal residual tooth. The antrostomy is first carried out using a tungsten carbide spherical blur, the surgical template acting as a guide; when the sinus membrane begins to appear, one can switch to using a piezoelectric handpiece, with appropriate inserts.

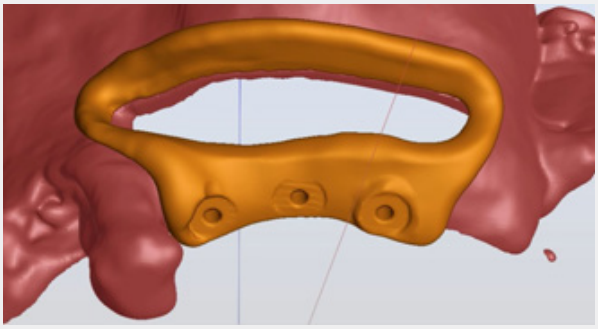

Figure 5: To design the surgical guide, a "raw" .STL object is superimposed to the alveolar process and the portion corresponding to the Low Window antrostomy is removed. The guide is matched, using the guided surgery software, to the implant position planning and adapted to guide implant insertion. Finally, the guide is printed.

Figure 6: Pre-surgical panoramic X-ray and sinus CBCT.

The sinus membrane is detached according to the same procedures used in the traditional approach; the detachment may be carried out using an appropriate piezoelectric insert first, to mobilize the membrane, and then using manual sinus elevators or curettes. As will be explained later, the position of the inferior line flush with the sinus floor and the mesial line flush with the anterior sinus wall facilitate detachment. This is especially true for the anterior sinus recess, a part of the sinus in which the detachment of the membrane is notoriously troublesome and difficult. The sinus is grafted according to standard procedures, using either autogenous bone and/or a bone substitute. The authors usually place a collagen membrane under the sinus membrane to protect it and graft an equine-derived xenograft. They place a collagen or equine-derived cortical bone membrane to protect the antrostomy (the latter being stabilized using taps or screws). External-internal suturing [17] using non-resorbable suture material is followed by suturing of the mucoperiosteal flaps using non-resorbable suture material. A complete clinical case is shown in Figures 6-10. Informed consent was obtained from patients.

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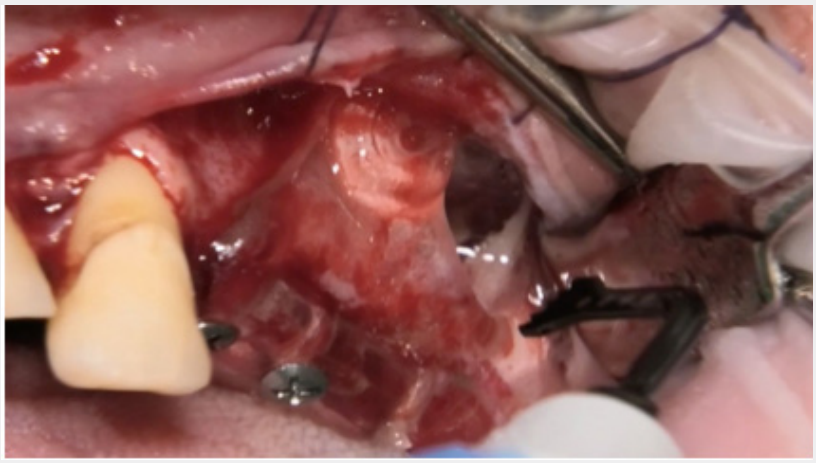

Figure 7: The Low Window surgical guide is stabilized using some screws. After performing the antrostomy, the sinus membrane will be lifted, and the sinus grafted. The implant site will be prepared using the same surgical guide.

Figure 8: 3 days after surgery the patient shows no swelling nor bruising.

Figure 9: A post-operative control panoramic X-ray.

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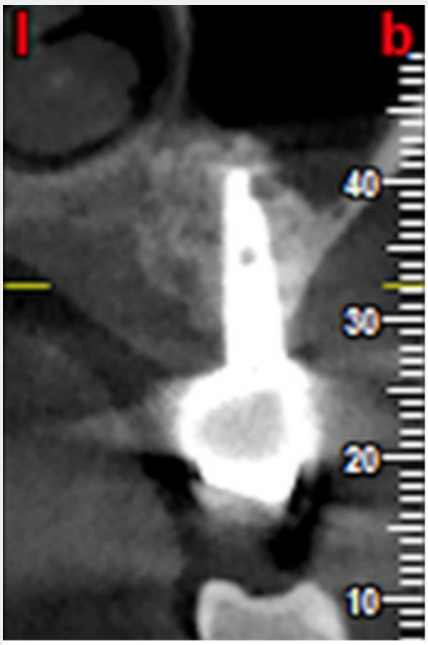

Figure 10: A ≥ 9-month CBCT showing the bone gain that could be achieved.

Discussion

The Low Window Technique involves a series of standardized surgical steps and is therefore easy to learn, repeatable, and less error-prone than the traditional freehand method. Because it involves the use of digital software to create a surgical template, it helps the surgeon perform osteotomies with precision [18-21]. The Low Window Technique allows easier access to the sinus and reduces invasiveness. Detachment of the sinus membrane is facilitated and because the mesial osteotomy line is flush with the anterior sinus wall and the inferior border is flush with the sinus floor, the movements the surgeon makes with the elevators to detach the membrane are smooth and linear as they first run parallel to the anterior wall and sinus floor and then move upwards. Membrane detachment is facilitated, especially in the area of the anterior recess. This potentially reduces the risk of rupture of the membrane, a known complication of intraoperative sinus augmentation [1-6,22-25]. In the Low Window Technique, incisions are limited to a linear incision. No release incisions are made, and the flap is elevated a maximum of 10 mm. This is expected to result in a better postoperative course characterized by less pain, hematoma, and swelling than the traditional method. In addition, because of the low window height and minimal flap elevation, a flexible lip and cheek retraction device can be used, saving the patient intraoperative and postoperative discomfort. In the authors' experience, the low-window sinus lift technique does not affect other important sinus augmentation variables, such as the volume of biomaterial required or the length of implants to be placed, and it does not preclude the possibility of simultaneous vertical/horizontal ridge augmentation through guided bone regeneration, if required.

Published evidence on the Low Window Technique is currently limited to an anecdotal case report [18] and a retrospective case series [19] analyzing the records of 28 surgeries involving 22 patients who received 79 implants and were followed-up for 38.4 ± 13.2 months. There were no cases of intraoperative perforation of the sinus membrane or other complications, and patients reported a high level of satisfaction. At final follow-up, all prostheses and implants were successful. Retrospective data analyses are currently being performed to assess the long-term bone gain achieved by the Low Window Technique, as well as immediate postoperative discomfort, pain, hematoma and bruising. Prospective split-mouth studies are also being planned to compare the Low Window Technique with more traditional, freehand procedures. Overall, the Low Window Technique saves chair time during clinical procedures because it consists of a series of standardized surgical steps that reduce the risk of intraoperative and postoperative complications as well as the patient's postoperative discomfort. It is easy to learn, repeat, and less error-prone than traditional, freehand methods and reduces the level of difficulty associated with lateral wall techniques [26].

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