

Case Reports

Evaluation of Subantral Membrane Balloon Elevation Technique Using Cone-beam CT

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Edentulous maxilla is found to be encumbered by alveolar resorption and increased pneumatization of the sinus. To create an improved environment in such regions, classic sinus floor elevation with bone augmentation is well-accepted technique; however, when the edentulous area is limited to a zone between 1 and 2 teeth, and arteries exist in the lateral wall of the window area, lifting the membrane becomes difficult and dangerous. The antral membrane balloon elevates the membrane easily and this technique is minimally invasive surgery for sinus floor elevation.

The purpose of this study is to evaluate the efficacy of the antral membrane balloon elevation technique.

Key words: Balloon technique, Sinus, Minimal invasive surgery

INTRODUCTION

In the posterior maxillary segment, which has insufficient bone quality and quantity to support dental implants, vertical height is more frequently a problem than the width of the alveolar ridge.

Traditionally, clinicians have used two approaches to perform bone augmentation in the inferior aspect of the maxillary sinus; the lateral maxillary window approach ("hinge osteotomy") and the "osteotome technique", also called bone-added osteotome sinus floor elevation. The lateral approach yields a modest bone height increment that can be estimated according to the initial bone height. Moreover, this procedure can be complicated by membrane perforation and tearing, which can be minimized with a skilled technique and delicate instrumentation. The lateral maxillary window offers a satisfactory average implant survival of 91.8% (ranging from 61.7% to 100%)¹⁾.

Compared to minimally invasive methods, the major shortcomings of this method are potential nerve and vascular injury, requirement of good surgical skills, and patient discomfort. Lateral bone fenestration has limitations similar to hinge osteotomy.

The subantral membrane balloon technique uses both the lateral window, osteotome and minimally invasive techniques.

The purpose of this case report is to demonstrate the efficacy of the subantral membrane balloon elevation technique using cone-beam CT.

MATERIALS AND METHODS

Eleven consecutive patients with teeth missing in the

posterior maxilla underwent water balloon sinus floor elevation. The balloon used in this case report is a Subantral Membrane Elevator kit (SME, OTA, CA, USA) composed of a 5 ml Luer Lock syringe, mini-balloon, PCV (Polycarbonate Vinyl) tubing and metal shaft. (Fig. 1) Sterilized saline solution is used to expand the balloon. Three different configurations are available. (Fig. 2) The straight BSL (Balloon for Sinus Lift) features a 3.1 mm diameter shaft and has 4 ml capacity. It is typically used for the osteotome, socket or closed technique through an extraction site. The micro-mini BSL has a 1.9 mm shaft and 1.5 ml capacity. It is typically used for entry through the implant osteotomy site when placing a very small implant. The angled BSL also has a 3.1 mm shaft and 4 ml capacity. It is designed for an antral approach using the *Caldwell-Luc* window or open technique. (Fig. 3) Usually, 1 ml fluid equals 1 ml graft material and 6 mm height or elevation — the amount of fluid used to inflate the balloon is in direct proportion to the amount of graft material required. For example: if 9 mm elevation is desired, it should be inflated using a maximum of 1.5 ml saline. (1 ml saline equals approximately 6 mm \pm 0.5 mm). The procedure is shown in Tables 1 and 2. Tables 3 and 4 are shown indication and contraindication of balloon technique. The biomaterial graft is 500-1000 mesh β -tricalcium phosphate particle (Bioresorb, Oratronics). The graft sites were evaluated with regard to the radiographic quantity using cone-beam CT before and after surgery.

RESULTS

All 11 patients successfully completed the procedure. No perforation of the membrane was observed by the

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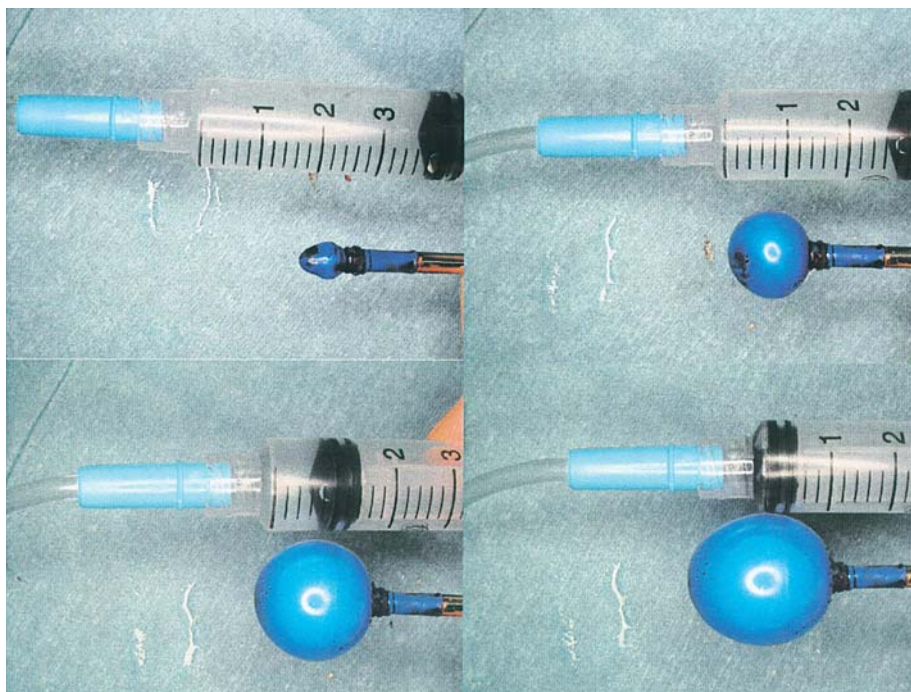


Fig. 1 : Graft material required is in direct proportion to the amount of fluid used to inflate the balloon: 1 ml of fluid will require 1 ml of graft material.



Fig. 2 : Three different configurations are available. The straight BSL features a 3.1 mm diameter shaft and has a 4 ml capacity. It is typically used for the osteotome, socket or closed technique through an extraction site.

breathing test among lateral approach cases. In all cases it took within 10 min. to perform the membrane elevation. There were no major complications and the survival rate of all implants after 3 years in this case report was 100%. Nine cases had a sufficient volume for implant placement but 2 cases of lateral window approaches had an insufficient volume medially (Figs. 4 and 5).

DISCUSSION

Elevation of the maxillary sinus floor was first reported by Boyne in the 1960s. Fifteen years later, Boyne & James²⁾ reported elevation of the maxillary sinus floor in patients with large, pneumatized sinus cavities in preparation for the placement of blade implants. It is evident that the reduced vertical bone height in the posterior maxillary region often limited standard implant placement. Elevation of the maxillary sinus floor is an option in solving this

problem. Various surgical techniques³⁾ have been presented to enter the sinus cavity elevating the sinus membrane and placing bone grafts. To date, two main techniques of sinus floor elevation for dental implant placement are in use: a two-stage technique. The sinus membrane was elevated, and implants were inserted and left to protrude into the sinus cavity. The sinus membrane was allowed to settle onto the apices of the implants, thus creating a space to be filled with blood coagulum. After a mean follow-up time of 5 years, the survival rate of these implants was 90%⁴⁾. It must be kept in mind, however, that the residual bone height in this study was at least 3 mm.

In 2003, Wallace and Froum¹⁾ published a systematic review on the effect of maxillary sinus floor elevation and the survival of dental implants. The criteria for review included human studies with a minimum of 20 interventions, a follow-up time of one year of functional loading and with the outcome variable of implant survival being reported. The main results indicated:

1. The survival rate of implants placed in conjunction with sinus floor elevation with the lateral approach varied between 61.7 % and 100 %, with an average of 91.8%.
2. Implant survival rates compared favorably with the reported survival rates for implants placed in non-grafted maxillae.
3. Rough surfaced implants yielded higher survival rates than machined surface implants when placed in grafted sinuses.
4. Particulate autografts showed higher survival rates than those placed in sinuses that had been augmented with block grafts.
5. Implant survival rates were higher when barrier membranes were placed over the lateral window.

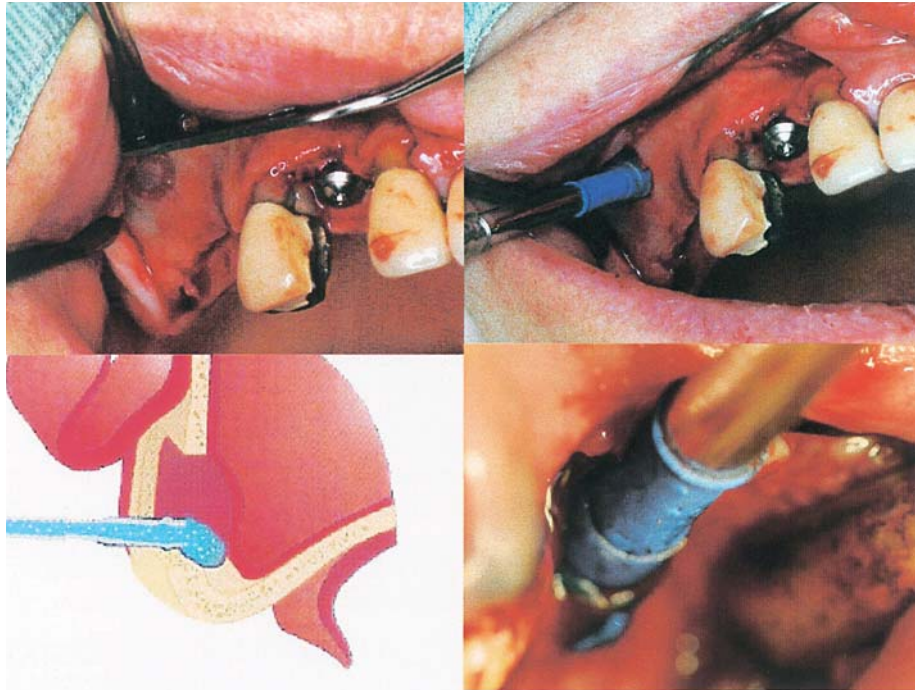


Fig. 3 : SME gives predictable results, decreases surgical time and minimizes the possibility of membrane tears. A typical single-tooth procedure that generally takes 30 to 45 minutes will probably take 10 to 15 minutes with the BSL.

Table 1. Lateral approach technique

LATERAL APPROACH

- 1) Reflect full thickness soft tissue flap
- 2) Create osteotomy of lateral wall of sinus cavity with rotary instrument
- 3) Introduce balloon into osteotomy site
- 4) Slowly inject 1-4 ml of saline solution into mini-balloon via tubing
- 5) Deflate balloon using syringe and remove from sinus cavity
- 6) Inspect sinus membrane and confirm integrity
- 7) Place graft material of choice

Table 2. Alveolar ridge approach technique

ALVEOLAR RIDGE APPROACH

- 1) Reflect full thickness soft tissue flap
- 2) Create osteotomy of alveolar ridge of sinus cavity with rotary instrument and osteotomes (3.5-4.0 mm in diameter)
- 3) Introduce balloon into osteotomy site
- 4) Slowly inject 1-4 ml of saline solution into mini-balloon via tubing
- 5) Deflate balloon using syringe and remove from sinus cavity
- 6) Inspect sinus membrane and confirm integrity
- 7) Place graft material of choice

Table 3. Indication of SME technique

Indication

- 1) An adjunct to Maxillary Sinus Membrane Elevation Procedures in Preparation for Grafting
- 2) Single tooth or 2 teeth gap

Table 4. Contraindication of SME technique

Contraindication

- 1) Acute or chronic sinusitis
- 2) Latex allergy
- 3) Perforation of membrane during osteotomy

6. The utilization of grafts consisting of 100 % autogenous bone or the inclusion of autogenous bone as a component of composite grafts did not affect implant survival.

Many papers have documented sinus floor elevation (SFE) as a predictable procedure; however, this is a technically sensitive procedure.

Major complications are membrane perforation, and post-operative infection and bleeding⁵⁻⁷). Recently, Piezo instruments have been used to open the window of the lateral wall but the risk of perforation when the membrane was elevated from the sinus floor remains. The procedure using subantral membrane balloon elevation is less technically sensitive than the conventional procedure and is a minimally invasive surgical technique⁸). The soft balloon inflates with sterilized saline solution via a tube. The pressure from the syringe is equal according to the Pascal principle. The unique balloon makes it easy to perform atraumatic membrane elevation; however, from sagittal CT findings in the lateral approach, the medial membrane is difficult to elevate sufficiently because the shape of the balloon is a sphere. Additional elevation is necessary medially using conventional instruments.

CONCLUSION

The procedure of sinus floor elevation using subantral membrane balloon elevation is predictable, decreases sur-

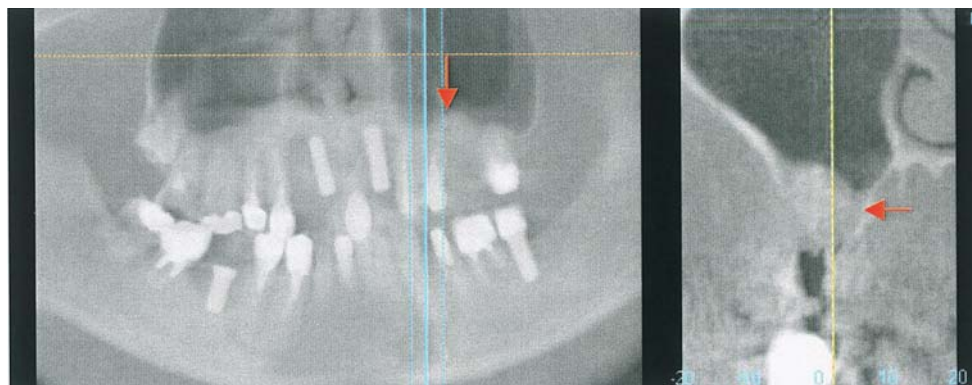


Fig. 4 : Panoramic and CT images of grafting site after surgery. Grafting material was filled by medial wall. Red arrows show the grafting site.

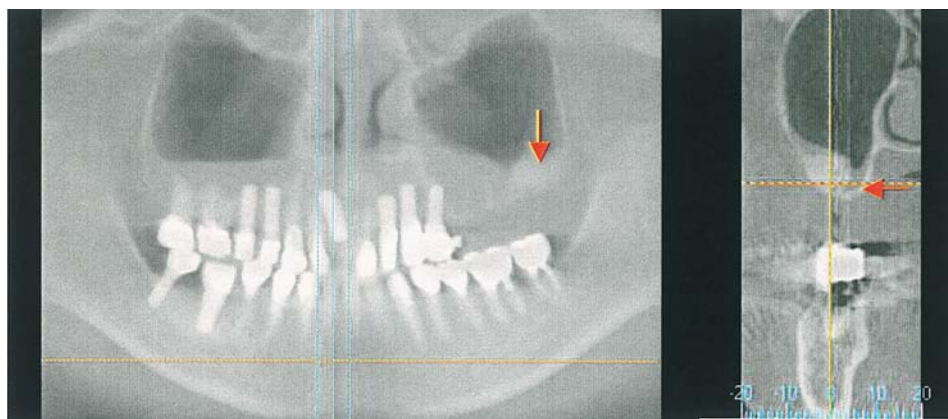


Fig. 5 : Panoramic and CT images of grafting site after surgery. Grafting material was not fill by medial wall. Red arrows show the grafting site.

gical time and minimizes the possibility of membrane tears even in a complex anatomy. This procedure shortens the operating time. A typical single-tooth or multi-tooth procedure that generally takes 30 minutes will take 10 to 15 minutes with the BSL. The balloon technique performs atraumatic membrane elevation and a low incidence of infection and bleeding are observed. Regarding CT evaluation, it is difficult to elevate the medial membrane because of the ball shape. When we use the lateral window technique, additional elevation is necessary medially with conventional instruments.

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バルーンテクニックを用いた上顎洞底挙上術の コーンビームCTを用いた評価

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上顎臼歯部においては歯槽骨の吸収ならびに上顎洞の拡大が認められる。サイナスリフトはそのような部位を改善するために十分に受け入れられている方法である。しかしながら1歯, 2歯に限局された部位や側壁に動脈が存在する場合, 側壁を拡大することは困難であり, 危険が伴う。バルーンテクニックは安全にシュナイダー膜の剥離を行い, 低侵襲な方法である。この研究の目的はバルーンを用いた症例についてその有効性についてコーンビームCTを用いて評価することである。

キーワード：バルーン技法, サイナス, 最小侵襲

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