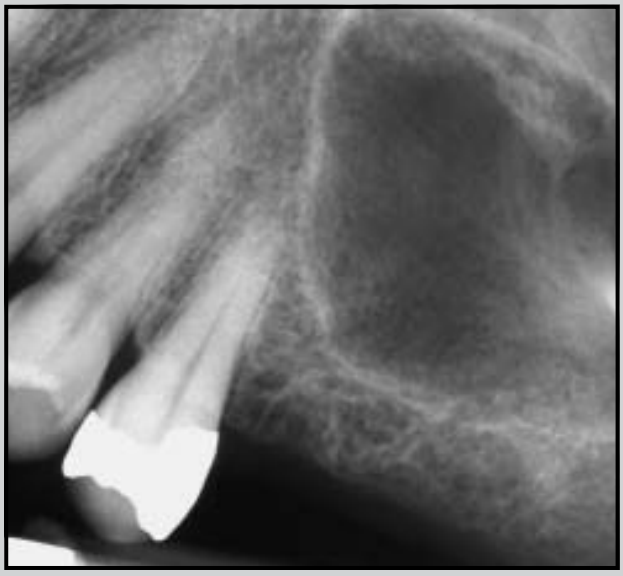

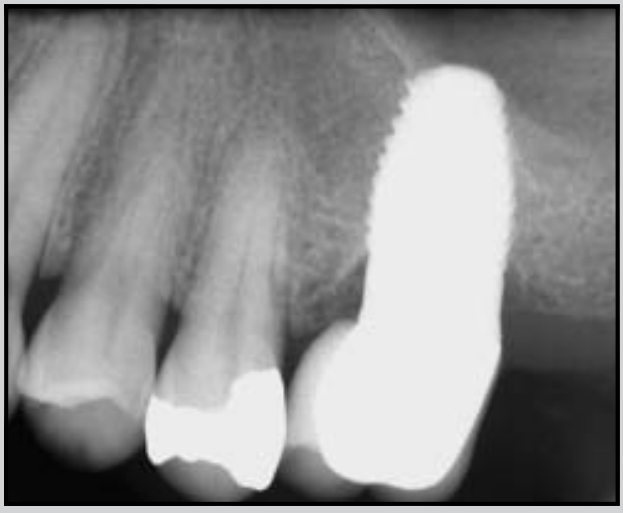

Sinus Floor Augmentation with a Hydropneumatic Technique: A Retrospective Study in 40 Patients

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The use of a hydropneumatic balloon for the elevation of the sinus membrane is a new technique for sinus floor augmentation procedures. Few cases using such a technique are reported in the English medical literature. This report describes 40 patients who were treated with this technique and studied retrospectively. Forty consecutive patients with an alveolar crest–sinus floor distance (bone height) ≤ 12 mm were enrolled. Under microscopy (40×) and using piezosurgical instruments, hydropneumatic sinus membrane elevation was performed, and a calcium sulphate solution was injected under the elevated antral membrane using a syringe. In the same surgical session, 4.00- to 6.50-mm-diameter implants were placed. Bone height at 12 months, complications related to the surgical technique, and implant failure were all recorded. Bone height at 12 months was 14.66 ± 1.48 mm, with a sinus membrane elevation of 9.01 ± 3.01 mm. Fifty-six implants were placed, and no failures were observed after 1 year. One macrolaceration and two microlacerations were the only complications related to the technique. Minimal invasiveness and reduced trauma characterize this new approach. In fact, gradual balloon inflation provides a controlled and atraumatic preparation of the sinus floor membrane. Piezoelectric instruments and microscopy make this technique predictable and safe. The relatively short learning curve of this approach for sinus floor elevation allows for its use in private practice. (Int J Periodontics Restorative Dent 2012;32:205–210.)

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Implant rehabilitation of edentulous arches with conventional techniques has demonstrated great predictability when the remaining bone is sufficient, with success rates of 84% to 92%.[1–3] On the contrary, in patients with severe upper maxillary resorption, the scenario is more complicated. In fact, bone centripetal resorption, pneumatization of the sinuses, and the presence of the nasal fossae and the nasopalatal duct, together with bone of quality type 3 or 4 according to the classification of Lekholm and Zarb,[4] are factors that frequently complicate or make implant placement impossible. The Sinus Consensus Conference held in 1996[5] found that sinus floor elevation is effective in restoration of the maxilla and, in many cases, is the unique alternative that permits implant placement and prosthetic rehabilitation. Sinus floor elevation and augmentation should be considered an evidence-based and clinically established method for implant prosthetic rehabilitation of the atrophic posterior maxilla, with an overall cumulative survival rate of 90% within a mean observation

Table 1 Microscope use in the surgical approach

Surgical step	Magnification	Type of vision
Flap incision and alveolar crest exposure	4–6×	Direct
Use of pilot drill	6–8×	Direct
Breaking of sinus floor	8–12×	Indirect
Sinus membrane integrity control	12–16×	Indirect
Initial elevation with spheric probes	10–14×	Indirect
Balloon and sleeve membrane elevation	8–14×	Indirect
Sinus membrane integrity control	12–16×	Indirect
Calcium sulphate positioning	8–12×	Indirect
Implant placement	4–8×	Direct
Suture	6–10×	Direct

period of 4 years.[6] The survival rate of implants placed in sinuses augmented with the lateral window technique varied between 61.7% and 100%, with a mean survival rate of 91.8%.[7]

The two widely used approaches to sinus augmentation are the lateral maxillary window and the transcrestal technique by osteotome. The meta-analysis conducted by Emmerich et al on sinus floor elevation using osteotomes concluded that, "Short-term clinical success/survival of implants placed with an osteotome sinus floor elevation technique seems to be similar to that of implants conventionally placed in the partially edentulous maxilla."[8] Nevertheless, membrane laceration or perforation and orosinusal communication are the most common complications related to the technique and operator experience.

In this report, the authors describe a minimally invasive transcrestal technique for sinus augmentation using a hydropneumatic balloon for elevation of the sinus membrane.

Method and materials

Patients exhibiting the following characteristics were included in this study: more than 18 years of age, presence of edentulous posterior maxillary segment (monolateral or bilateral), and alveolar crest–sinus floor distance (bone height) ≤ 12 mm. Patients were excluded if they met any of the following criteria: smokers who smoke more than 10 cigarettes/day and presence of chronic and acute sinusal diseases, osteoporosis, or diabetes.

Each patient received an explanation of the procedures, and informed consent was obtained.

Study protocol

Panoramic and periapical radiographs were obtained before the procedure. An XCP Rinn Kit (Rinn) was used to standardize the angulations of the periapical films to avoid differences in radiographs before and after the sinus floor augmentation and implant positioning. Computed tomography was also requested in all selected cases. Augmentin (1 g twice daily) was initiated 24 hours before surgical intervention. All surgical interventions were performed under microscopy (Karl Kaps). Table 1 reports how the microscope was positioned and used throughout the procedure. Local anesthesia (infiltration of the posterior superior alveolar nerve and palatine nerve) was obtained by 4% articaine. A paracrestal full-thickness flap with palatal bias and vertical mesial incision were executed to expose

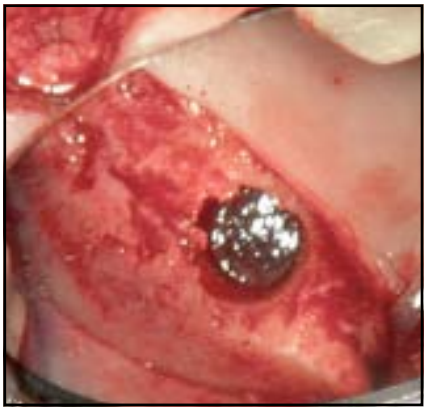


Fig 1 *Sinus floor highlighted after use of the pilot drill and piezosurgical instruments.*

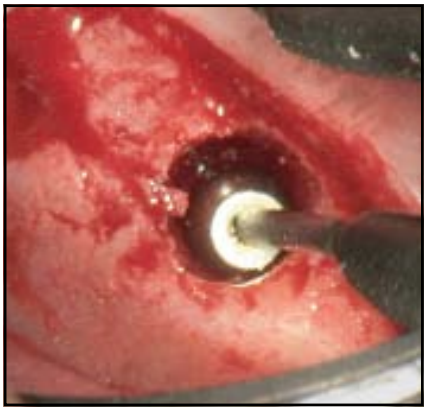


Fig 2 *Sinus membrane elevation using a spheric probe.*

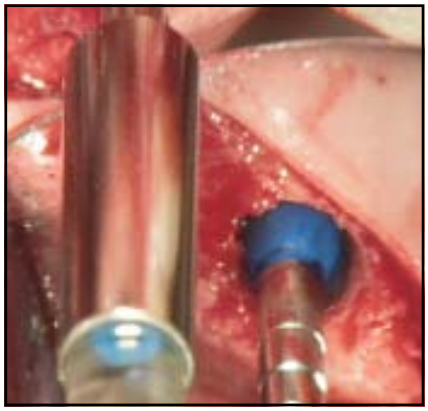


Fig 3 *Positioning of the Subantral Membrane Elevator in the space obtained between the sinus floor and the antral membrane.*

the alveolar crest. The pilot drill was stopped 1 mm from the sinus floor. With a dedicated piezosurgical tip, the sinus floor was gently broken (Fig 1). Initial elevation of the sinus membrane was obtained using a spheric probe (Fig 2). An inflatable balloon connected to a sleeve (Subantral Membrane Elevator, OTA) of 1.8-mm diameter was positioned in the space between the sinus floor and the partially elevated membrane (Fig 3). The balloon was inflated slowly with a normal saline solution (1 mL/min) (Figs 4a and 4b). The integrity of the antral membrane was controlled for every 2 mL of saline solution pumped into the balloon. Inflation was stopped at 4.5 mL of saline solution to avoid the risk of balloon rupture. Once the desired elevation was obtained (usually ≤ 20 mm), the balloon was deflated and removed using the sleeve. A calcium sulphate solution (Newplaster Sinus, Class Implant) was injected under the elevated antral membrane using a syringe (Figs 5a and 5b), and 4.00- to 6.50-mm-diameter implants were placed (BioHorizons Implant System). Patients were discharged with a single 550-mg dose of naproxen sodium for treatment of pain and amoxicillin associated with clavulanic acid 1 g bid for 7 days. Suture removal was executed within 7 days.

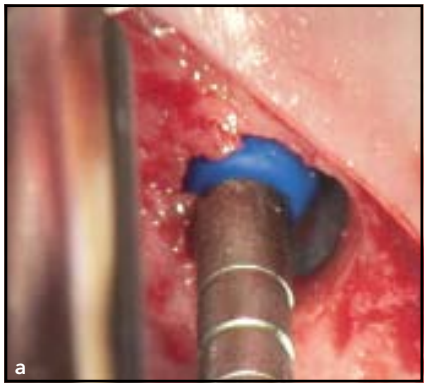
Bone height was recorded at the initial visit and at 12 months. Major complications related to the surgical technique, including severe bleeding, infection, nerve injury, and sinus membrane perforation, and implant failure were also recorded.

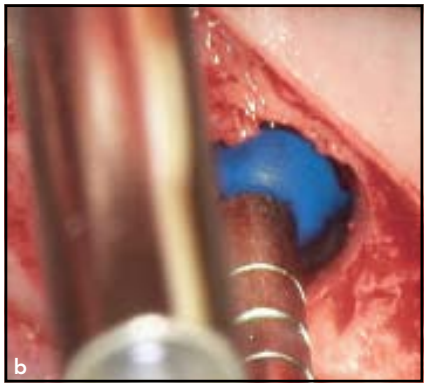
Results

A cohort of 40 consecutive Caucasian patients were enrolled from February 2000 to March 2006. All patients were treated by the same operators at the Department of Dentistry and Surgery, University of Bari, Bari, Italy. Table 2 gives the demographic data related to the patients recruited for this study.

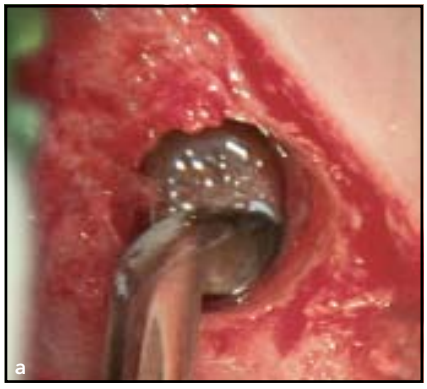
The mean age of patients was 41.5 years, and the male-to-female ratio was 2:3 (16 men, 24 women). Baseline bone height was 8.00 ± 2.19 mm, while at the 12-month follow-up, a mean gain of 6.66 mm was recorded. Mean sinus membrane elevation was 9.01 mm. A total of 56 implants were placed, with the lengths and diameters carefully selected in relation to the anatomical characteristics of the recipient site (Table 3).

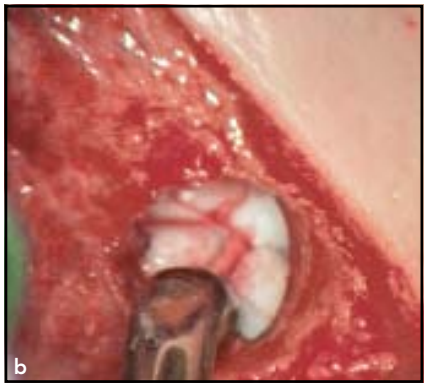
Table 4 lists the complications observed over the study period. An antral membrane macrolaceration of 5 mm was noted in one patient and treated with collagen.





Figs 4a and 4b *Gradual balloon inflation with a normal saline solution.*





Figs 5a and 5b *Injection of calcium sulphate solution under the elevated antral membrane.*

Table 2 Patient characteristics

Mean age (y)	41.5 (women, 39.7; men, 44.3)
Male:female ratio	16:24 (2:3)
Initial bone height (mm)*	8.00 ± 2.19
Bone height at 12 mo (mm)*	14.66 ± 1.48
Sinus membrane elevation (mm)*	9.01 ± 3.01

*Mean ± standard deviation.

Two other patients received single microlacerations with diameters smaller than 1.5 mm, which spontaneously resolved. No implant failure occurred after 12 months. Four patients complained of postoperative edema related to the inobservance of the correct therapeutic regimen prescribed after the surgical session.

A representative radiologic case is shown in Figs 6a to 6d.

Fig 6a *Preoperative radiograph.*

Fig 6b *Implant placement after sinus augmentation.*

Fig 6c *Implant loading.*

Fig 6d *Follow-up after 12 months.*

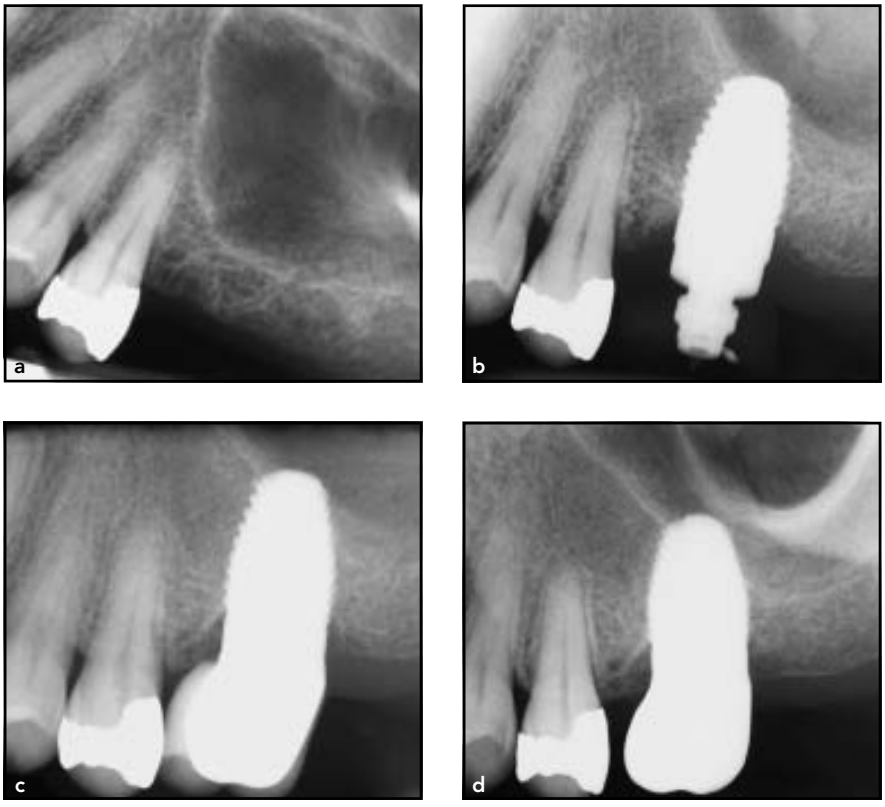


Table 3 **Implant characteristics**

Implant dimensions (mm)	No. of implants (n = 56)
4 × 13	23
5 × 13	12
4 × 15	10
5 × 11.5	5
5 × 15	2
6.5 × 11.5	2
6.5 × 13	2

Table 4 **Complications recorded over the study period**

Membrane complications	1 macrolaceration, 2 microlacerations
Hemifacial edema	4 patients
Implant failure	0

Discussion

This study reports a new approach to sinus membrane elevation using the hydropneumatic technique. This procedure avoids the risks related to the invasiveness of the lateral maxillary window and permits a comparable sinus membrane elevation. In addition, the gradual balloon inflation provides a controlled and atraumatic preparation of the sinus floor membrane. Piezosurgical instruments are essential to maintain the integrity of the sinus membrane during access to the sinus cavity; in fact, these surgical instruments do not work in contact with the soft tissues.

Muronoi et al[9] first reported the antral membrane balloon elevation technique as a modification of the classic technique via lateral bone fenestration. They used a hemostatic nasal balloon in 25 patients, observing only a low incidence of sinus infection and bleeding.[9]

Soltan and Smiler[10] improved the balloon technique and applied grafting materials to plane implant placement. Successive reports from Sotirakis and Gonshor[11] underline the advantages of hydraulic pressure to elevate the antral floor for bone grafting between the sinus floor and membrane before placement of endosseous osseointegrated implants. Kfir et al[12] reported the largest cohort of patients treated with the hydropneumatic technique. Successful results were obtained in 91.6% of the initial 12 patients and 100% in the second 12 cases without significant complications and with excellent implant stability. Similar successful results were performed in their most recent cases series.[13]

The hydropneumautic technique may have strong implications for clinical practice as well as for research. The minimally invasive approach and reduced trauma that characterize this new approach could be further improved using piezoelectric instruments and a microscope, which minimize the risk of membrane perforation and increase patient compliance. Furthermore, implants can be placed in the same surgical session, reducing the overall oral rehabilitation period. The relatively short learning curve of this approach for sinus floor elevation may consent its use in private practice, as suggested by Kfir et al.[12]

Further studies, particularly randomized controlled studies with a long follow-up period, are needed to better understand the potentiality of this technique. Information derived from anecdotes and case series may be important in planning well-designed clinical trials.

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