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Space-maintaining management in maxillary sinus lifting: a novel technique using a resorbable polymeric thermo-reversible gel

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Abstract. Several techniques have been proposed to achieve sinus floor elevation and the formation of new bone through the grafting of autologous, heterologous, or alloplastic materials. The grafted materials act as a scaffold for bone formation inside the maxillary sinus. This study investigated a non-graft sinus lifting procedure using a resorbable polymeric thermo-reversible gel. A space-maintaining approach to sinus lifting, using a resorbable polymeric thermo-reversible gel, was applied in 11 patients undergoing implant treatment in the atrophic posterior maxilla. After a healing period of 6 months, a total of 14 implants were placed; biopsies were taken and evaluated histologically and histomorphometrically. The parameters evaluated included the percentages of new bone formation, residual gel, and fibrous tissue. Histological examination showed the formation of new bone with no fibrous tissue or severe inflammatory cellular infiltration. The percentage of newly formed bone was in the range of 54–60%; this consisted of both lamellar and woven bone. No foreign-body reaction was observed. The mean quantities of both residual gel and connective tissue were small. This non-graft sinus lifting procedure using a space-maintaining gel appears to stimulate predictable bone formation; it is thus a useful technique for promoting bone formation in the sinus.

Key words: maxillary sinus; sinus lift; maxillary sinus augmentation; polymeric gel; dental implant.

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In attempting dental implant placement in the posterior zone of the maxilla, pneumatization of the maxillary sinus can cause difficulties. Furthermore, the progressive atrophy that often results from the extraction of one or more teeth means that the clinician must deal with an inadequate alveolar ridge and poor quality bone. Several surgical techniques have been proposed to achieve sinus floor elevation and thereby the formation of new bone, so as to enable optimal implant positioning. Most of these techniques involve elevating the

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Schneiderian membrane of the sinus, grafting autologous, heterologous, or alloplastic materials, and then positioning a titanium implant. The grafted materials act as a scaffold for bone formation inside the maxillary sinus, confirming the osteoinductive properties of the Schneiderian membrane.[1,2]

However, the use of grafting materials is not a prerequisite for predictable bone formation: several clinical and experimental studies have reported maxillary sinus floor augmentation achieved simply by lifting the sinus membrane, without applying any graft materials.[3–15] These studies employed different surgical methods, using either lateral[5–8,16] or crestal approaches,[17–19] and all achieved successful implant stability and adequate new bone formation. This type of bone augmentation procedure is thus clearly viable for an atrophic posterior maxilla, and may give predictable results.

Studies of guided bone regeneration have shown that good bone regeneration can be achieved with the use of blood clots alone, without inserting bone grafts.[9,20,21] However, respiration produces air pressure in the maxillary sinus, which may cause the blood clot to shrink during the healing stages in non-graft sinus lifting. In an experimental study of sinus augmentation using blood clots alone, the clots were observed to collapse during the early postoperative healing period, leading to instability of the newly formed bone; the study reported only a small amount of new bone around the implants, and the vertical gain of new bone was insufficient for stability.[22] The study authors attributed this poor result to the air pressure within the maxillary sinus that, with the respiration pattern, alters the blood clot, significantly reducing the augmented space, and leading to insufficient new bone formation. Further, if atrophy is severe, the implant cannot be placed; maxillary sinus floor augmentation must be performed prior to the insertion of the implants.

Considerable surgical skill is required in the use of space-maintaining devices. Furthermore, the devices currently available for this type of procedure are unstable and rigid, which may lead to membrane perforation.

This study tested a resorbable polymeric thermo-reversible gel for maxillary sinus augmentation in patients with severe maxillary atrophy, and examined the clinical, radiographic, and histological outcomes. The gel used is a specific mixture of poloxamers (predominantly poloxamer 407). These materials are used primarily in pharmaceutical formulations as emulsifying, solubilizing, and stabilizing agents to maintain the clarity of syrups or elixirs. They can also be used as wetting and lubricating agents. The objective was to use the gel as a space maintaining device, with the goal of achieving stable elevation of the sinus membrane through a simple, economical surgical technique, exploiting the osteoinductive properties of the Schneiderian membrane.

Materials and methods

Protocol

The study included 11 patients (six male and five female; mean age 51 years, range 30–70 years). All patients enrolled in the study presented atrophy of the posterior maxilla and agreed to undergo implant-supported prosthesis placement. The patients were fully informed of the study methods and provided their written consent to participate. The institutional review board approved all study protocols. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and was approved by the local ethics committee.

Inclusion criteria were the following: atrophy of the posterior maxilla with healthy sinuses, with a minimum residual alveolar crest height of $\leq$4 mm (Figs 1 and 2); no disease affecting the neighbouring teeth; non-smoker. Exclusion criteria were the following: diseases of the maxillary sinuses; uncontrolled systemic diseases such as diabetes; acute sinus infections; chemotherapy; radiotherapy within 12 months before surgery in the head and neck region.

Data on the residual alveolar crest height before and after surgery were recorded by computed tomography (CT).

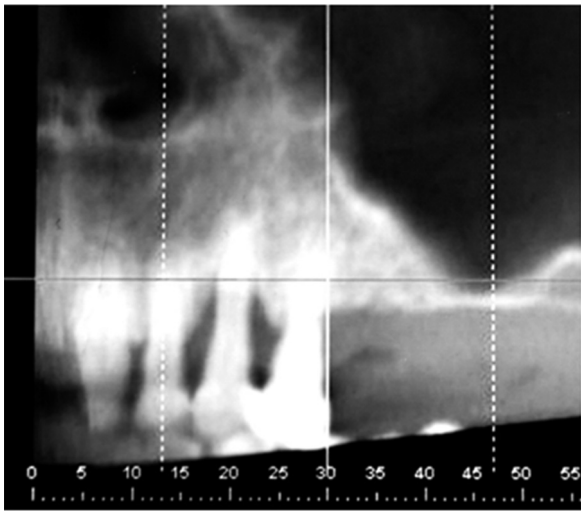

Fig. 1. CT slice of the maxilla at baseline (frontal section): note the severe bone resorption.

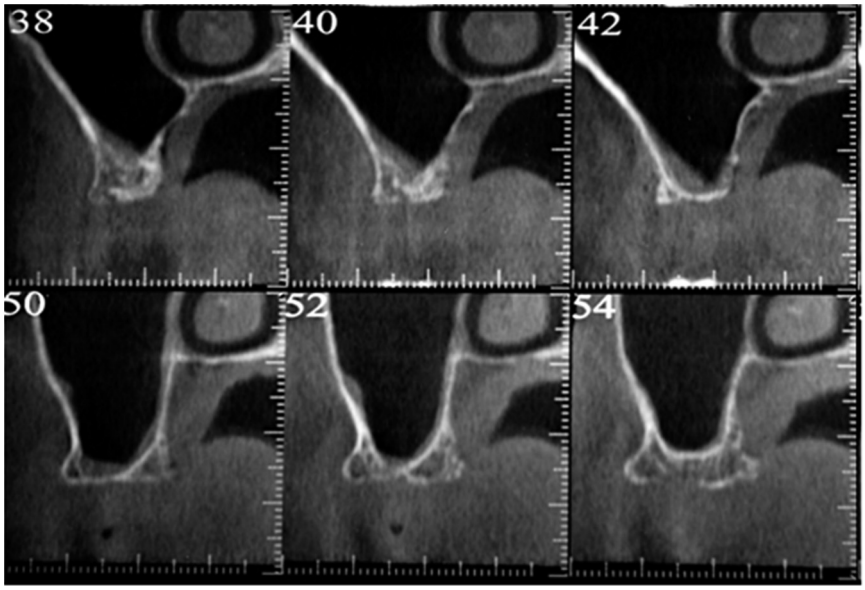

Fig. 2. CT slices of the maxilla at baseline (sagittal sections): note the severe bone resorption.

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