In the posterior maxilla, tooth extraction induces progressive and irreversible vertical bone resorption. This leads to an atrophic bone situation and limits the application of implant therapy. In such cases, the sinus lift procedure with bone augmentation is indicated; it is expected to facilitate implant primary stability, provide sufficient bone for optimal implant osseointegration, and provide long-term success.¹

The lateral window technique was first described by Boyne and James¹ in 1980. It is the most frequently used procedure for vertical bone augmentation of the atrophic posterior maxilla. It requires a significant volume of bone harvested from a donor site. The
latter increases the patient’s postoperative discomfort, pain, swelling, bruising, and risk of infection. An alternative to the lateral approach is the osteotome sinus floor elevation procedure. It is less invasive and the treatment can be achieved with a single surgery. The reliability of short implants with a textured surface has been well documented. In sites with limited residual bone height (RBH), the surgical procedure is simpler, and the treatment duration can be reduced. For example, Renouard and Nisand reported a cumulative survival rate of 94.6% after 2 years of loading for 96 short implants placed in severely resorbed posterior maxilla. Recently, the need for autologous bone grafts and grafting material to achieve successful sinus augmentation procedures has been questioned. In sites in which the mean residual bone height was 5.4 mm, Nedir et al showed that the osteotome sinus floor elevation procedure without bone grafting material could lead to a mean endosinus bone gain of 2.5 ± 1.2 mm. The latter was even found to be inversely correlated with the RBH (ie, the lower the RBH, the greater the bone gain).

The present report addressed the treatment of 2 patients who presented with a mean RBH of 3.2 mm in the posterior maxilla. The patients asked for the simplest and least invasive treatment. This led the practitioner to choose a surgical protocol other than the classic lateral window procedure. These patients were treated by combining the osteotome sinus floor elevation procedure, without a grafting material, with the simultaneous placement of short tapered implants with a reduced thread pitch.

**Materials and Methods**

**CASE 1**

A 48-year-old white man came to our institution for rehabilitation of his left edentulous posterior maxilla. His general health was good without a contributive medical history. The patient was a heavy smoker (about 20 cigarettes daily) but had stopped smoking before treatment. Despite protracted periodontal therapy, the patient had had extensive alveolar bone loss. The “resistant periodontitis” required extraction of all the teeth from this posterior quadrant.

The periapical radiograph taken before surgery (Fig 1A) revealed a large procident sinus cavity, extending around the apex of the cuspids. The presence of a septum was identified at the former position of the second premolar. The RBH was 3.0 mm at the former position of the first premolar, 5.0 mm of the second premolar, and 1.1 mm of the first molar. Prophylactic antibiotics (Amoxi-Mepha; Mepha Pharma SA, Aesch, Switzerland; 750 mg, 3 times daily) were given the day before surgery and for 6 days after surgery. A mid-cresial incision was performed for flap elevation; vertical and periosteal release incisions were avoided. Cortical bone marking, for site positioning, was performed with 3 round burrs of increasing diameters from 1.4 to 3.1 mm (Fig 2A). The 2.8 mm-diameter sinus osteotome (Straumann AG, Basel, Switzerland) was engaged to push the sinus floor axially. The use of osteotomes instead of drills prevented ovalization of the implant bed in the limited residual bone. The sinus floor was then broken by light strokes with a mallet. It was then carefully pushed into the sinus cavity to a maximal height of 3 mm; the Schneiderian membrane was further elevated by implant placement. The osteotomy site was enlarged by the 3.5-mm-diameter sinus osteotome. The integrity of the membrane was controlled with an undersized depth gauge of 2.1 mm; however, microperforation of the Schneiderian membrane could not be excluded. No grafting material was used. Three tapered, 8-mm-long, TE implants, 4.8 mm-diameter at the collar and 4.1 mm at the apex (Straumann AG), were placed in the prepared osteotomy sites. Implant insertion was performed without tapping. The flap was sutured around the implant neck, allowing for nonsubmerged healing (Fig 2B). The blood clot with bone particles surrounding the implants could be clearly seen on the postoperative radiograph (Fig 1B). During surgery, the bone quality at the implant sites was categorized according to Trisi and Rao: normal at the site of the first premolar and soft at the sites of the second premolar and first molar. All 3 implants achieved primary stability.

The healing period was uneventful and lasted 3.6 months. The space delimited by the elevated Schneiderian membrane was maintained over time by the implants. The classic prosthetic steps were then performed, and a cemented porcelain-fused-to-metal prosthesis composed of 3 splinted crowns was placed. At the 1-year follow-up, all implants were clinically stable, and the final prosthesis was functioning (Fig 2C). All implants gained endosinus bone; the mean gain was 5.5 ± 1.4 mm and varied from 4.7 to 7.1 mm. All implants were entirely embedded in the newly formed mineralized tissue (Fig 1C). The mean crestal bone loss was 1.1 ± 0.3 mm. At 2 years, the bone levels were stable (Fig 1D).

**CASE 2**

A 77-year-old white man presented for rehabilitation of his left posterior maxilla that had been edentulous for several years. He was a previous smoker who was in good general health with a noncontributive medical history. The RBH beneath the sinus was 3.0 mm at the second premolar and 3.5 mm at the first molar. The surgical procedure was similar to that performed for patient 1. The only difference was that the osteotome sequence ended
with the 4.2-mm diameter sinus osteotome, instead of the 3.5-mm diameter sinus osteotome used for the 4.8-mm diameter implants for patient 1. This was because larger diameter implants were planned. The 10-mm-long tapered implants, 6.5 mm in diameter at the collar and 4.8 mm in diameter at the apex (Straumann AG), were inserted at sites 25 and 26.

Both implants achieved primary stability. After an uneventful healing period of 3.6 months, the implants were clinically stable. Abutment screwing with a torque of 20 Ncm did not lead to implant rotation. The final prosthesis was functioning at the 1-year follow-up visit. A dental computed tomography scan and panoramic and apical radiographs were performed at the 1-year follow-up visit. Newly formed mineralized tissue on each implant side was clearly visible on the 1-year radiographs (Figs 3, 4). The mean bone gain and crestal bone loss was 5.0 and 0.4 mm at the implant in the site of the second premolar and 3.6 and 0.5 mm at the implant at the site of the first molar. Thus, the net bone gain was 4.6 mm at the implant at the site of the second premolar and 3.1 mm at the implant at the site of the first molar. After 3.5 years, the implants were clinically and radiographically stable.

Discussion

For the 2 patients, the available prosthetic height, measured from the bony crest of the edentulous sites to the opposing dentition, was about 9 mm; therefore, endosinus augmentation was indicated rather than crestal augmentation. The standard current clinical practice would have required a sinus-lift procedure with autologous bone grafting and delayed implant placement. This treatment would have required 6 to 8 months of healing to allow for bone formation at the grafted area and a second healing period of 3 to 4 months after implant placement (ie, 9 to 11 months of healing instead of 3.6 months). Furthermore, in patient 1, the lateral approach would have been complicated by the presence of a septum and might have led to membrane perforation.

Both patients required the least invasive and shortest treatment. The osteotome sinus floor elevation
procedure, although technically demanding with an RBH of less than 5 mm, was minimally invasive. Because the Schneiderian membrane can support elevation in the sinus cavity of 4 to 8 mm,15 the required elevation of the sinus floor could be obtained.16

To enhance the primary stability in low-density bone, the use of osteotomes is more relevant than the use of drills. By compression, the osteotomes can laterally condense bone and create a denser interface at the placed implants,17 improving the initial bone-to-implant contact.18

Implant stability could be achieved despite the limited RBH down to 1.1 mm; this was because of the conical implant design, the threads brought up to the implant neck, and a reduced pitch of 0.8 mm. The classic parallel-walled design of the used implant system, with its 1.25-mm thread pitch starting 1 mm away from the neck level, would not have


allowed for primary stability in these demanding situations.

The osteotome sinus floor elevation procedure described by Summers\textsuperscript{19,20} involves a grafting material that is condensed in the osteotomy site to elevate the sinus membrane. If the Schneiderian membrane is perforated, the filling material can migrate into the sinus and lead to inflammation.\textsuperscript{21,22} The present protocol, by avoiding use of a grafting material, has completely eliminated this risk. With this technique, undetected perforations are likely to remain uneventful because the membrane can reform around protruding implants.\textsuperscript{23}

The findings from these 2 cases, with a mean of 5.1 mm of endosinus bone gain, are also questioning the necessity of using a grafting material in sinus augmentation procedures. Despite the lack of grafting material, the 1- and 2-year radiographs consistently showed the implants embedded into newly created bone and the new apically switched demarcation of the sinus. Also, the additional bone height usually gained by the grafting material placed above to the implant apex has been shown to resorb with time, as quickly as 1\textsuperscript{24} or 3\textsuperscript{25} years. Amazingly, it will be stabilized at the implant apex\textsuperscript{24} or slightly below it.\textsuperscript{25} Therefore, that apical bone gain in this procedure is limited by the implant length should not be considered a limitation or a specific drawback of this technique without a grafting material.

Short implants were used in these 2 cases to minimize the risk of membrane perforation. This could be contemplated, because it has now been well documented that rough-surfaced short implants, in contrast to machine-surfaced implants, are as reliable as longer implants.\textsuperscript{3,4,7,26-28}

In summary, tapered implants with a reduced thread pitch could be placed with good primary stability in the atrophic maxilla of 2 patients using an osteotome sinus floor elevation procedure without grafting material. The regenerative properties of the bone beneath the sinus floor led to high endosinus bone gain.

\textbf{FIGURE 3.} Dental computed tomography scan of patient 2, with oblique coronal reconstructions of the sites of the second premolar and first molar. A (1-9), Before implant placement; B (1-9), at 1-year follow-up visit. A3, B3, Site of the second premolar; and A6, B6, Site of the first molar.


The advantages of this procedure were the avoidance of invasive surgery and permitting treatment within a single surgical step. Before bringing this treatment protocol into more routine clinical practice, more cases and longer follow-up are warranted. However, these 2 cases, successful in the short term, suggest that room might exist to treat the atrophic maxilla with a surgical procedure other than the classic lateral window opening for sinus augmentation.

References