Sinus floor elevation is a well-documented and predictable surgical procedure. Lateral access is the most common approach, and various solutions for the use of the bony window have been proposed. The bony window might be discarded or used as part of the graft. Alternatively, the bony window might be elevated while it is still attached to the sinus mucosa as a cortical bone graft or repositioned to protect the antrostomy at the end of the sinus floor elevation. The technique that includes the elevation inward of the bony window has been applied for sinus floor augmentation without the use of grafting material. In a retrospective study, sinus floor elevation was performed in 33 patients, and 47 implants were placed in the same surgical session. The reported success rate was 100% after 2 years. In a clinical trial, in 44 patients, 80 implants were placed simultaneously to a sinus floor augmentation procedure. After 5 years of function, a 100% success rate was reported with a marginal bone loss of 2.1 mm.

A similar surgical procedure was also used in conjunction with biomaterials in human studies. Sixty-two sinus floor elevations were performed in 42 patients, and 161 implants were placed simultaneously. In a follow-up from 1 to 6 years, no implants were lost. In a randomized clinical trial, 48 sinus floor elevations were performed in 37 patients. Either deproteinized bovine bone mineral (DBBM) or biphasic calcium phosphate were used as filler materials. Biopsy specimens were collected between 180 and 240 days after surgery. Similar proportions of new bone were found in both groups.
The bony window has been repositioned on the antrostomy after sinus floor elevation without the use of grafting material and with simultaneous implant placement.\textsuperscript{12,13} A high clinical success rate was reported. This procedure has also been studied in an experiment in rabbits,\textsuperscript{14} in which the elevated space was grafted using \(\beta\)-tricalcium phosphate. The antrostomy at one sinus was protected using a collagen membrane, while that on the other side was covered with the bony window. A difference in bone formation within the elevated space of approximately 10\% in favor of the repositioned bony window was observed after 8 weeks of healing. In another similar study in rabbits, a xenograft was used as filler material.\textsuperscript{15} The repositioned bony window was fixed to the antrostomy edges with a cyanoacrylate glue while the other antrostomy was protected with a collagen membrane. After 8 weeks of healing, the bony window was found to be consolidated to the new bone that was formed within the elevated space.

Few data are available on the healing of the repositioned bony window. However, no data could be found in literature on the healing on the bony window displaced inward in the elevated space. Therefore, the objective of this study was to evaluate the influence on healing of the bony window elevated inward in the sinus cavity as a cortical bone graft.

The hypothesis was that the bony window might improve bone formation within the elevated space.

**MATERIALS AND METHODS**

**Ethical Statement**

The Ethical Committee of the School of Dentistry, Ribeirão Preto, USP, Brazil, approved the protocol #2017.1.278.58.9 on June 14, 2017. The ARRIVE checklist and the SYRCLE’s risk of bias tool for animal studies were followed. The Brazilian guiding principles for animal experiments were strictly followed.

**Study Design**

Eighteen rabbits were included in the present experiment, adopting a split-mouth design. Both maxillary sinuses were used to simulate a lateral approach for sinus floor elevation. At the test sites, randomly allocated at the right or left sinuses, the bony window was displaced within the sinus cavity and elevated together with the sinus membrane. At the control site, the bony window was removed before sinus mucosa elevation. The rabbits were separated into three groups, each comprising six animals. The healing was studied after 2, 4, and 8 weeks from surgery.

**Experimental Procedures**

The anesthesia of the rabbits was performed with 1.0 mg/kg of acepromazine (Acepran, Vetnil) subcutaneously and 3.0 mg/kg of xylazine (Dopaser, Hertape Calier) and 50 mg/kg of ketamine hydrochloride (Ketamin Agener, União Química Farmacêutica Nacional) intramuscularly. Anesthesia was injected locally.

All surgical procedures were performed by a maxillofacial surgeon specialist (E.R.S.). An incision of \(\sim 2.5\) cm was carried out on the skin in the midline of the nasal dorsum, and rectangular antrostomies, 3 mm wide and 4 mm in height, were prepared with drills approximately 1 cm below the frontal-nasal suture, and laterally to the nasal-incisal suture. A bony window resulted in the center of the antrostomy. In the control group, the bony window was gently detached and discarded, and the mucosa of the sinus was elevated using small sinus elevators (Bontempi Strumenti Chirurgici). In the test group, the bony window was left attached to the sinus mucosa (bony window group). The mucosa was detached from the sinus bone walls and pushed inward together with the bony window (Fig 1a). Similar volumes of 0.250- to 1.0-mm granules of DBBM (Bio-Oss, Geistlich Biomaterials) were grafted within the elevated space.
space (Fig 1b). Collagen membranes (Bio-Gide, Geistlich Biomaterials) were placed on antrostomies (Fig 1c).

Euthanasia
A similar anesthesia as that used for the surgery was applied, and the euthanasia was accomplished with a lethal dose of sodium thiopental (1.0 g, 2 mL, Thiopen-tax, Cristália Produtos Químicos Farmacêuticos). Biopsy specimens were obtained in blocks and fixed in 10% buffered formalin.

Experimental Animals
Eighteen New Zealand male rabbits of approximately 4 to 5 months of age and approximately 3.4 kg of weight were chosen for the experiment at the fazenda de coel-hos Chacara Uniao, Cidade Taquaritinga, SP, Brazil.

Housing and Husbandry
Prior to, during, and after the experiment, all rabbits were maintained in individual cages in rooms with controlled light and temperature at the experimental facilities of the School of Dentistry, USP, Ribeirão Preto, Brazil. Professionals took care of the animals for the full period of the experiment. Wounds, pain, infection, and biologic functions were monitored.

The animals received a prophylactic dose of oxy-tetracycline dihydrate (40 mg/kg, intramuscularly, Tertiary LA, Zoetis Indústria de Produtos Veterinários). Postoperatively, the animals received ketoprofen (3.0 mg/kg, intramuscularly, Ketofen, Merial) and tramadol hydrochloride subcutaneously (Tramadol 2%, 1.0 mg/ kg, Cronidor, Ageren União Saúde Animal).

Sample Size
No data were available from previous experiments on a displaced bony window. The sample calculation was made on the data from an experimental study on sinus floor elevation in rabbits. In that experiment, the bony window was repositioned at one antrostomy, while the opposite one was covered with a membrane of collagen. A difference in bone formation within the elevated sinus of approximately 10% in favor of the repositioned bony window sites was observed after 8 weeks of healing, with the mean values presenting a very low standard deviation (~20% of the mean values). Based on these data, with a power of 0.8 and a type I error of 0.05, six animals were calculated to be sufficient to disclose differences.

Randomization and Allocation Concealment
The website www.randomization.com was used for the randomization of the treatments by one author (D.B.) that did not participate in the surgery. Sealed and opaque envelopes containing the allocation treatment were prepared and were opened after the preparation of the antrostomies by an author not involved in the surgery (S.P.X.).

MicroCT Evaluations
The block sections were scanned in a high-resolution MicroCT 1172 (Bruker). For details about the parameters used, see Iida et al. The percentage of bone contained within the full elevated volume (including new bone and the displaced bony window) in an anterior-posterior plane was reported.

Histologic Preparation and Analyses
After dehydration and inclusion in resin, two ground sections representing the most central zone of the sinuses were prepared and stained with either Stevenel’s blue and alizarin red or toluidine blue. For details of the histologic procedures, see Iida et al.

The following regions within the elevated space were evaluated (Fig 2): bone walls, submucosa, middle, and close-to-window. The regions close to the border (edges) and center (center) of the antrostomy were also evaluated.
RESULTS

All samples were analyzed both histologically and with microCT so that an n = 6 was achieved for all periods included in the experiment.

Histologic Analysis in the Elevated Region

After 2 weeks of healing (Fig 3a), the presence of the bony window positively influenced new bone formation both within the elevated space (Table 1) and in the submucosal region (Table 2). The higher fractions of new bone found in the elevated space in the test group (bony window group; 5.2% ± 2.9%) compared with the control group (2.5% ± 2.4%; \( P = .046 \)) were mainly related to the higher content of new bone within the submucosa region, which was 9.0% ± 3.9% in the test group and 0.5% ± 0.1% in the control group (\( P = .028 \)). In the other regions evaluated, similar proportions of new bone were disclosed in both the test and the control groups, presenting higher content in the bone wall region compared with the middle and close-to-window regions.

After 4 weeks of healing (Fig 3b), newly formed bone percentage increased in comparison to the previous period of healing and, within the elevated space, reached similar proportions in both groups. In the submucosa region, 13.2% ± 5.2% and 3.4% ± 4.3% were found in the bony window and control groups, respectively (\( P = .028 \)).

After 8 weeks of healing (Fig 3c), new bone further increased in proportions within the elevated space, reaching 21.3% ± 6.1% in the test group, and 25.4% ± 3.2% in the control group (\( P = .173 \)). In the submucosa region, 18.5% ± 2.5% and 13.3% ± 8.1% of proportions of new bone were found in the test and control groups, respectively (\( P = .345 \)).

Similar patterns of healing were observed in the antrostomy in both test and control groups. After 2 weeks of healing, new bone was found forming from the

| Table 1 Tissue Components in the Elevated Area at the Test and Control Sites at the Various Periods of Healing (Mean ± SD Values in Percentages) |
|---------------------------------|----------------|----------------|-----------------|----------------|----------------|----------------|----------------|
|                                 | New bone       | Residual bony window | Total bone | Xenograft       | Marrow spaces | Dense matrix | Loose matrix  |
| 2 wk test                       | 5.2 ± 2.9*     | 19.4 ± 0.9*          | 24.7 ± 2.9* | 37.8 ± 4.2*     | 2.4 ± 4.5*    | 20.4 ± 4.5* | 12.6 ± 2.5*   |
| 2 wk control                    | 2.5 ± 2.4*     | 0.0 ± 0.0*           | 2.5 ± 2.4*  | 51.9 ± 3.0*     | 1.0 ± 1.1*    | 25.0 ± 4.1* | 17.1 ± 3.6*   |
| 4 wk test                       | 14.0 ± 8.6     | 21.6 ± 2.9*          | 35.6 ± 79*  | 30.7 ± 7.6      | 8.1 ± 6.9     | 13.8 ± 6.6 | 9.9 ± 2.3     |
| 4 wk control                    | 13.6 ± 7.0     | 0.0 ± 0.0*           | 13.6 ± 70*  | 48.2 ± 5.0      | 8.3 ± 5.3     | 15.8 ± 5.2 | 12.2 ± 5.6    |
| 8 wk test                       | 21.3 ± 6.1     | 20.1 ± 5.3*          | 39.2 ± 10.0* | 28.3 ± 5.2*     | 10.4 ± 6.6    | 7.4 ± 4.3  | 9.0 ± 7.5     |
| 8 wk control                    | 25.4 ± 3.2     | 0.0 ± 0.0*           | 25.4 ± 3.2* | 42.4 ± 2.7*     | 17.2 ± 4.2    | 6.1 ± 2.3  | 6.6 ± 4.0     |

*\( P < .05 \) between test and control sites.
Table 1 Tissue Components in the Elevated Area at the Test and Control Sites at the Various Periods of Healing (Mean ± SD Values in Percentages)

<table>
<thead>
<tr>
<th>Component</th>
<th>Test 2 wk</th>
<th>Test 4 wk</th>
<th>Test 8 wk</th>
<th>Control 2 wk</th>
<th>Control 4 wk</th>
<th>Control 8 wk</th>
</tr>
</thead>
<tbody>
<tr>
<td>New bone</td>
<td>5.2 ± 2.9*</td>
<td>19.4 ± 0.9*</td>
<td>24.7 ± 2.9*</td>
<td>2.5 ± 2.4*</td>
<td>0.0 ± 0.0</td>
<td>0.5 ± 0.1</td>
</tr>
<tr>
<td>Residual bony window</td>
<td>0.0 ± 0.0</td>
<td>0.0 ± 0.0</td>
<td>0.2 ± 0.2</td>
<td>0.0 ± 0.0</td>
<td>0.0 ± 0.0</td>
<td>0.0 ± 0.0</td>
</tr>
<tr>
<td>Dense matrix</td>
<td>14.0 ± 8.6</td>
<td>21.6 ± 2.9*</td>
<td>35.6 ± 7.9*</td>
<td>13.6 ± 7.0</td>
<td>13.6 ± 7.0</td>
<td>13.6 ± 7.0</td>
</tr>
<tr>
<td>Loose matrix</td>
<td>1.8 ± 0.8</td>
<td>0.3 ± 0.4</td>
<td>0.4 ± 0.6</td>
<td>0.5 ± 0.9*</td>
<td>3.4 ± 4.3*</td>
<td>13.3 ± 8.1</td>
</tr>
<tr>
<td>Connective tissue</td>
<td>21.3 ± 6.1</td>
<td>20.1 ± 5.3*</td>
<td>39.2 ± 10.0*</td>
<td>25.4 ± 3.2</td>
<td>25.4 ± 3.2</td>
<td>25.4 ± 3.2</td>
</tr>
<tr>
<td>Vessels</td>
<td>0.7 ± 1.7</td>
<td>12.8 ± 12.9*</td>
<td>21.3 ± 13.0</td>
<td>0.1 ± 0.3</td>
<td>19.3 ± 11.8*</td>
<td>32.1 ± 4.9</td>
</tr>
<tr>
<td>Inflammatory infiltrate</td>
<td>0.0 ± 0.0</td>
<td>10.7 ± 11.7</td>
<td>15.6 ± 10.2</td>
<td>0.2 ± 0.5</td>
<td>9.6 ± 9.4</td>
<td>26.5 ± 9.2</td>
</tr>
<tr>
<td>Osteoclastic zone</td>
<td>0.0 ± 0.0</td>
<td>12.8 ± 12.9*</td>
<td>21.3 ± 13.0</td>
<td>0.0 ± 0.0</td>
<td>12.8 ± 12.9*</td>
<td>21.3 ± 13.0</td>
</tr>
</tbody>
</table>

*P < .05 between test and control sites.

Table 2 New Bone Percentages (%) in Various Regions Within Elevated Area Evaluated After 2, 4, and 8 Weeks of Healing (Mean ± SD)

<table>
<thead>
<tr>
<th>Region</th>
<th>2 wk</th>
<th>4 wk</th>
<th>8 wk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone wall</td>
<td>6.4 ± 5.1</td>
<td>17.1 ± 8.9*</td>
<td>27.0 ± 10.3*</td>
</tr>
<tr>
<td>Bone wall control</td>
<td>7.0 ± 6.9</td>
<td>22.9 ± 8.7*</td>
<td>33.4 ± 4.2*</td>
</tr>
<tr>
<td>Submucosa test</td>
<td>9.0 ± 3.9*</td>
<td>13.2 ± 6.9*</td>
<td>18.5 ± 2.5</td>
</tr>
<tr>
<td>Submucosa control</td>
<td>0.5 ± 0.9*</td>
<td>3.4 ± 4.3*</td>
<td>13.3 ± 8.1</td>
</tr>
<tr>
<td>Middle test</td>
<td>0.0 ± 0.0</td>
<td>10.7 ± 11.7</td>
<td>15.6 ± 10.2</td>
</tr>
<tr>
<td>Middle control</td>
<td>0.2 ± 0.5</td>
<td>9.6 ± 9.4</td>
<td>26.5 ± 9.2</td>
</tr>
<tr>
<td>Close-to-window test</td>
<td>0.7 ± 1.7</td>
<td>12.8 ± 12.9*</td>
<td>21.3 ± 13.0</td>
</tr>
<tr>
<td>Close-to-window control</td>
<td>0.1 ± 0.3</td>
<td>19.3 ± 11.8*</td>
<td>32.1 ± 4.9</td>
</tr>
</tbody>
</table>

*P < .05 between test and control sites.

Histologic Analysis of the Bony Window

The percentages of residual bony window were similar among the three periods of healing, showing dimensional stability over time. The bony window was found to be vital in all periods examined. Several areas of resorption and bone apposition, around and inside the bony window, were observed. The percentages of residual bony window were similar among the three periods of healing, showing dimensional stability over time. The bony window was found to be vital in all periods examined. Several areas of resorption and bone apposition, around and inside the bony window, were observed.

Fig 3 Photomicrographs of ground section illustrating the healing after (a) 2, (b) 4, and (c) 8 weeks of healing. The displaced bony window is visible in the (a) right, (b) left, and (c) right sinuses. Images grabbed at ×20 magnification. Stevenel’s blue and alizarin red stain.

Table 3 New Bone Percentage (%) Within Antrostomy Region Evaluated after 2, 4, and 8 Weeks of Healing (Mean ± SD)

<table>
<thead>
<tr>
<th>Region</th>
<th>Test 2 wk</th>
<th>Control 2 wk</th>
<th>Test 4 wk</th>
<th>Control 4 wk</th>
<th>Test 8 wk</th>
<th>Control 8 wk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edges</td>
<td>6.6 ± 9.3</td>
<td>12.2 ± 4.2</td>
<td>24.1 ± 7.8</td>
<td>24.3 ± 9.4</td>
<td>29.0 ± 8.5</td>
<td>32.9 ± 6.3</td>
</tr>
<tr>
<td>Center</td>
<td>0.4 ± 1.0</td>
<td>1.4 ± 3.4</td>
<td>12.2 ± 7.8</td>
<td>17.3 ± 8.3</td>
<td>27.0 ± 14.6</td>
<td>29.5 ± 9.3</td>
</tr>
<tr>
<td>Total</td>
<td>4.5 ± 6.5</td>
<td>8.7 ± 3.1</td>
<td>20.2 ± 7.7*</td>
<td>22.0 ± 8.1*</td>
<td>28.3 ± 9.4</td>
<td>31.8 ± 6.5</td>
</tr>
</tbody>
</table>

*P < .05 between test and control sites.
the bony window, were seen already after 2 weeks of healing (Fig 4a). In this period, new bone in direct contact with the surface of the bony window was 35.4% ± 7.1% and increased to 49.6% ± 11.5% and to 60.4% ± 10.8% after 4 and 8 weeks, respectively (Table 4). The bone on the surface of the window was in several instances connected by bridges of newly formed bone to the surrounding xenograft particles (Fig 4b) and to the subjacent new bone (Figs 5a and 5b). Concomitantly, the dense and loose matrix tissues in contact with the bone window surface decreased over time. Osteoclastic zones on the surface were observed in all periods, decreasing in percentages over time, while resorptive zones and basic multicellular units (BMUs) inside the bone window were seen in all periods examined. The direct contact of the sinus mucosa with the upper region of the bony window increased over time. Considering the whole surface of the bony window, the percentage

<table>
<thead>
<tr>
<th></th>
<th>New bone</th>
<th>Xenograft</th>
<th>Marrow spaces</th>
<th>Dense matrix</th>
<th>Loose matrix</th>
<th>Vessels</th>
<th>Osteoclastic zone</th>
<th>Sinus mucosa</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 wk</td>
<td>35.4 ± 7.1</td>
<td>0.4 ± 0.6</td>
<td>5.1 ± 4.6</td>
<td>35.0 ± 8.3</td>
<td>7.6 ± 6.2</td>
<td>0.4 ± 0.9</td>
<td>13.1 ± 3.2</td>
<td>3.0 ± 3.8</td>
</tr>
<tr>
<td>4 wk</td>
<td>49.6 ± 11.5</td>
<td>0.0 ± 0.0</td>
<td>4.5 ± 2.9</td>
<td>29.1 ± 12.0</td>
<td>1.1 ± 2.6</td>
<td>0.3 ± 0.6</td>
<td>6.1 ± 4.0</td>
<td>9.4 ± 10.4</td>
</tr>
<tr>
<td>8 wk</td>
<td>60.4 ± 10.8</td>
<td>0.0 ± 0.0</td>
<td>3.9 ± 7.1</td>
<td>7.8 ± 9.1</td>
<td>1.8 ± 3.5</td>
<td>0.0 ± 0.0</td>
<td>2.7 ± 1.4</td>
<td>23.4 ± 9.0</td>
</tr>
</tbody>
</table>

Table 4  Tissues in Contact with Bony Window Surface in Various Periods of Healing (Mean ± SD in %)

Fig 4  Photomicrographs of ground sections representing the healing after 2 weeks. (a) Ridges of new bone were formed on the bony window surface toward the sinus mucosa, while resorptive regions were visible on the opposite site. (b) Bridges of new bone were connecting the bony window to the neighbor granules of xenograft. ×100 magnification. Stevenel’s blue and alizarin red stain.

Fig 5  Photomicrographs of ground sections representing the healing after (a) 4 and (b) 8 weeks. New bone incorporated both the bony window and the xenograft particles. Grabbed at ×20 magnification. (a) Toluidine blue and (b) Stevenel’s blue and alizarin red stains.
of contact with the sinus mucosa was 6.2% ± 6.6% after 2 weeks and 25.4% ± 10.8% after 8 weeks of healing.

MicroCT Analysis
The percentage of the total amount of bone, including the bony window, within the elevated volume after 2 weeks of healing was 19.4% ± 2.3% in the test group and 18.2% ± 3.1% in the control group (P = .173; Fig 6). The percentage of bone slightly increased over time, with 20.5% ± 1.8% and 19.6% ± 1.9% after 4 weeks (P = .116) and 22.3% ± 1.6% and 22.2% ± 0.7% after 8 weeks, in the test and control groups, respectively (P = .686).

DISCUSSION
The objective of the present study was to evaluate the influence on healing of the bony window elevated inward in the sinus cavity as a cortical bone graft. It was shown that the bony window elevated together with the sinus mucosa positively influenced the healing in the first periods analyzed. However, after 8 weeks of healing, the proportion of new bone was higher in the control group compared with the test group (bony window group) due to the presence of the bony window. Including the bony window, the total bone percentage was higher in the test group in comparison with the control group. New mineralized bone increased over time within the elevated space in both the test and the control groups. The regions with the highest rate of bone formation were those close to the sinus bone walls, especially during the earliest periods of healing examined.

These outcomes agree with the data from other similar experimental studies in rabbits in which it was shown that the principal source of bone was the bone walls. In an experiment in minipigs, it was shown that the consolidation into new bone of the biomaterial used to fill the elevated sinus space started from the parent bone and, over time, propagated toward the sinus mucosa. The potential of forming bone attributed to the sinus mucosa has been shown by several studies. However, the participation in vivo of the sinus membrane in bone formation, at least considering the first periods of healing, was questioned in several studies. In two experimental studies in sheep, a collagen membrane was positioned below the sinus mucosa, aiming to obstruct a potential contribution of the sinus mucosa to form bone. No differences were disclosed in bone formation within the elevated space in comparison to the control sinuses, where no membranes were placed below the sinus mucosa. This called into question the role of the sinus mucosa in bone formation. A similar study design was applied in a rabbit model, and again, no differences were seen in new bone formation between the two groups.

It has to be considered that, after sinus floor elevation, the edema of the sinus mucosa and the bleeding consequent to the surgical trauma will increase the dimensions of the tissues above the filler material, or above the implants placed simultaneously. At the CBCT analysis, this phenomenon appears as an increase of the sinus mucosa dimensions that can reach > 9 mm after a transcortical approach for sinus floor elevation. The increased dimensions have been shown to be reduced to normality after 3 weeks. This transient swelling has been shown to also occur after sinus floor elevation using a lateral approach. In a study on sinus floor elevation using lateral access, it was shown that this edema disappeared spontaneously after 3 months of healing in 127 sinuses out of 132. Under such conditions, it might be challenging for the sinus membrane to participate in bone formation during the first periods after surgery, though this does not exclude its participation in a later period.

In the present experiment, during the surgical session, the bony window in the test group was maintained attached to the sinus mucosa, aiming to increase bone formation in this region. The bony window was found to be vital in all periods examined containing remodeling processes, and actively participating in bone formation. In fact, after 2 weeks of healing, new bone fraction within the submucosa region was 9.0% in the test group and 4.0% in the control group. In this stage, 35.4% of the bony window surface was covered by new bone. After 4 weeks of healing, the percentage of new
bone increased both at the test and control groups, as well as after 8 weeks of healing.

Considering the whole elevated space, higher fractions of new bone were seen in the control group (25.4%) compared with the test group (21.3%) after 8 weeks of healing. This difference in percentage was obviously due to the presence of the body of the bony window, only partially remodeled, which was occupying a large portion of the elevated space. In this final period examined, considering the bony window, the total amount of bone present in the elevated space reached proportions of 39.2% in the test group.

After 8 weeks of healing, higher percentages of new bone were present in the submucosa region in the test group in comparison with the control group. However, in all the other regions, higher proportions of new bone were present in the control group compared with the test group. This might be ascribed to the osteogenic properties of the bony window that act as a cortical bone graft. Moreover, it might be speculated that the presence of this autogenous bone might have attracted resources for bone formation at the expense of the other regions.

The bony window was only partly remodeled in all periods examined. After 8 weeks of healing, the surface of the bony window was incorporated into new bone for 60.4% of its surface. The incorporation of the bony window in the new bone formed within the elevated space found in the present study had already been described in other experiments in rabbits in which, in the test sites, the bony window was repositioned on the antrostomy at the end of the sinus floor elevation procedure.

It has to be considered that the dimensions of the bony window in this experiment in rabbits represented approximately 10% of the total elevated area. In humans, the bony window might represent less than 10% of the total volume of the elevated space, so its influence on healing might be lower in comparison with rabbits. Nevertheless, this bony window will be located on the top of the most relevant region where the implants will be placed, and this might influence the healing.

For limitations of the present study, it should be mentioned that the animal model used limits the inferences with humans. Longer periods of healing should be studied for further evaluations of the remodeling processes of the bony window. Moreover, the contribution of the microCT analysis was low due to the limits of the system used to discriminate between bone and biomaterial.

CONCLUSIONS

The presence of the bony window positively influenced the healing in the elevated space, especially in the submucosa region. The bony window was vital and incorporated into newly formed bone.

ACKNOWLEDGMENTS

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