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Sinus floor elevation with lateral approach and five-year follow-up

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Abstract

Introduction

The aim of this study is to evaluate sinus floor elevation utilizing the lateral approach and simultaneous or stage implant placement as a reliable treatment of edentulism in the posterior areas of the upper jaw with vertical bone deficit.

Material and Methods

We considered as indicated for sinus floor elevation utilizing the lateral approach, patients, who had subantral bone deficit, which was caused by pneumatization of the maxillary sinus in cases with normal distance between the edentulous alveolar crest and the occlusal surface of the opposite teeth or to the occlusal plane. Patients were scanned via cone-beam computer tomography. The sinus floor elevation utilizing the lateral approach was performed with simultaneous implant placement or with stage implant placement. The following criteria were observed: presence of intraoperative and early postoperative complications, survival rate for the period of study, bleeding on probing, and marginal bone resorption.

Results

The observation period is 4 to 5 years. The survival rate of the implants placed simultaneously with the sinus floor elevation utilizing the lateral approach is 99.2%, as for the stage implant placement it is 100%. The mean period for stage implant placement is 5.28 months after the subantral bone augmentation. The simultaneously placed implants were loaded 4 to 5 months after the placement and the stage placed implants - after 6 months.

Conclusion
Sinus floor elevation utilizing the lateral approach and simultaneous or stage implant placement, performed according to our methodology show high survival rate of the implants and high stability of the marginal bone.

Keywords: sinus floor elevations, lateral approach

Introduction

The aim of this study is to evaluate the survival rate of the implants, either stage placed or placed simultaneously with sinus floor elevation utilizing the lateral approach, the success rate of the augmentation procedures and the required height of the subantral bone which tolerates simultaneous placement of implants. A further aim is to assess the time after the procedure in which a sufficient strength of bone-to-implant connection is provided, which is required for successful functional loading. The mean period for stage implant placement was also evaluated.

Sinus floor elevation is proposed by Boyne (1) as a pre-prosthetic preparation of pneumatic tubers using autogenous bone and bone marrow. A number of modifications of the method were described later (2,3). In a systematic literature review, Jensen et al. (4) concluded that sinus floor elevation with the lateral approach requires mean height of the subantral bone of 3.8 mm, as for the same procedure with simultaneous implant placement the mean height of the subantral bone is 4.4 mm. Some authors report that the covering of the access window with a barrier membrane (5,6,7) prevents the bone grafting material from fibrous incapsulation from the fibrous connective tissue, which derives from the oral muco-periosteum. Valentini and Alberius (8) reported higher survival rate (96.8%) of staged implant placement with sinus floor elevation compared to implants placed simultaneously with sinus floor elevation utilizing the lateral approach (92.8%).

Material and Methods

We considered as indicated for sinus floor elevation utilizing the lateral approach, patients, who had subantral bone deficit, which was caused by pneumatization of the maxillary sinus in cases with normal distance between the edentulous alveolar crest and the occlusal surface of the opposite teeth or to the occlusal plane.

Patients indicated for sinus floor elevation utilizing the lateral approach were examined using cone-beam computer tomography (CBCT). The height of the subantral bone, the distance between the sinus floor and the alveolar ridge board, the width of the access window and the sinus width in the area planned for augmentation corresponding to the upper and lower edge of the access window were measured (Figure 1).

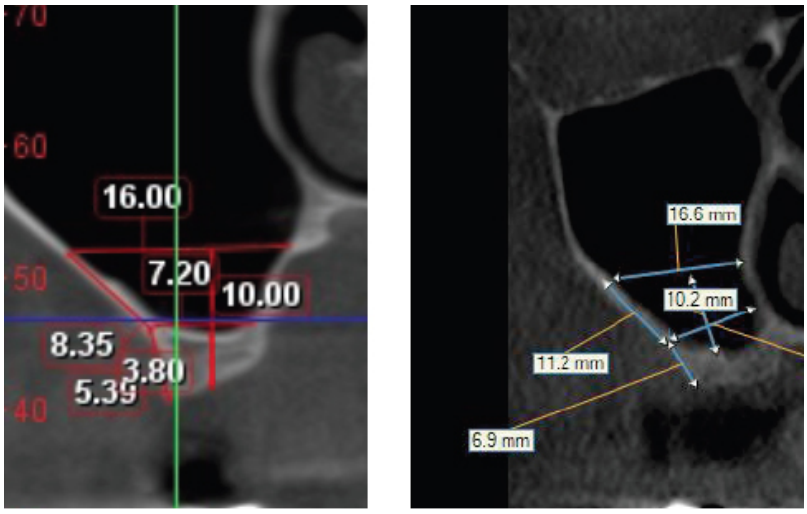

Figure 1. Measurements performed on CBCT to plan the osteotomy

The topography of the floor and the walls of the maxillary sinus in the area of the planned augmentation were inspected using a three-dimensional reconstruction by CBCT (Figure 2).

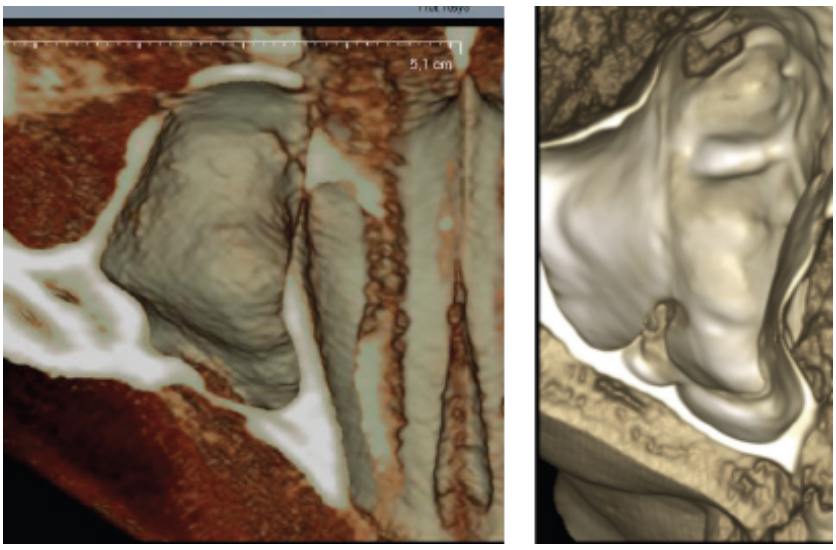

Figure 2. Visualization of the floor of the sinus via a 3D reconstruction

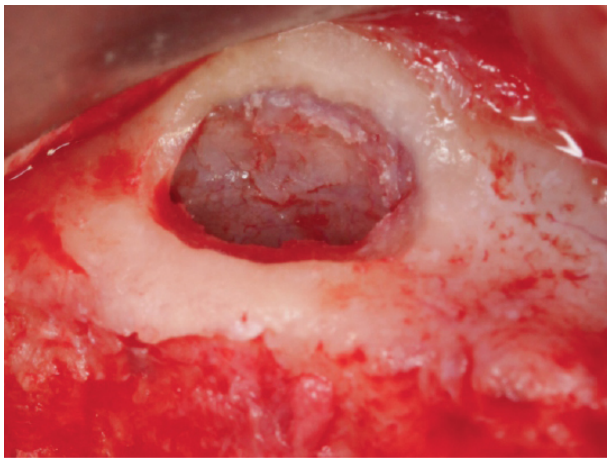

Figure 3. The elevated sinus membrane.

The e isting anatomical variations were considered(including the presence of a complete and/or partial septas, penetrating tooth roots, Figure 3. The elevated sinus membrane

The existing anatomical variations were considered (including the presence of a complete and/or partial septa, penetrating tooth roots, etc.) and pathological changes. Sinus floor elevation was performed after the elevation of the muco-periosteal flap, which provided access to the lateral wall of the maxillary sinus in the area of the planned augmentation. The osteotomy for providing an access window was done using a straight hand-piece and a diamond bur with a diameter of 3 mm, with a rotational speed of 10 000 rpm and cooling with sterile saline solution. After the osteotomy was done, the mucoperiost was elevated using sinus membrane elevators. Furthermore the integrity of the elevated sinus membrane was inspected (Figure 3).

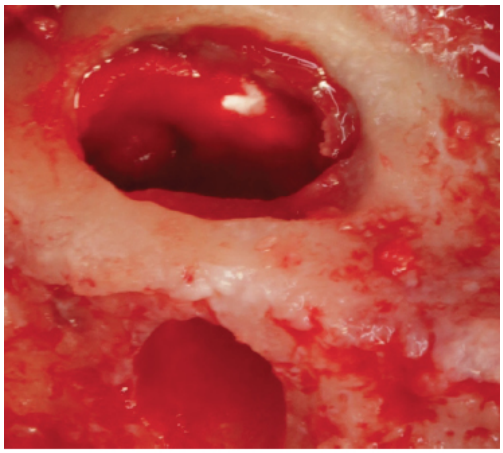

Figure 4. A collagen fleece inserted below the elevated sinus membrane

We considered that it was necessary to cover the placed implant with about 2 mm of bone grafting material. When the height of the subantral bone was minimum 2mm, the implant was placed simultaneously and the osteotomy in the subantral bone was performed in accordance with the implant producer's protocol (Straumann Bone Level implants - Institut Straumann, Basel, Switzerland), while the elevated sinus mucoperiosteum was protected using sinus membrane elevators. On the ceiling of the grafting cavity collagen fleece (Collagen fleece Botiss, Berlin, Germany) was placed, which quickly soaked with blood - Figure 4.

Then the bone grafting material was applied, from the mesial wall of the grafting cavity towards the access window. For this purpose autogenous bone in combination with platelet-rich plasma, biphasic calcium phosphate ceramics -Bone Ceramic (Institut Straumann -Basel, Switzerland), deproteinized bone mineral-Cerabone (Botiss, Berlin, Germany) and nano-hydroxyapatite water gel with particles of biphasic calcium phosphate ceramics - Maxresorb Inject (Botiss, Berlin, Germany) were used. Then the implants were placed. The access window was covered with a pericardial collagen barrier membrane (Jason Memb rane -Botiss, Berlin, Germany). The flap was repositioned and sutured with a single interrupted suture, using 5/0 monofilament polyamide suture (Dafilon, B.Braun-Melsungen, Germany).
The following criteria were taken into consideration and the data recorded:

1. Presence of intraoperative and early postoperative complications.
2. Residual bone measurements (the distance between the alveolar ridge and the sinus floor).The time for functional loading and the time before implant placement (for stage implant placement).
3. Survival rate for the period of the study.
4. Presence of marginal bone resorption visible on radiography.
5. Bleeding on probing.

Results

Sinus floor elevation and simultaneous implant placement
Patients receiving sinus floor elevation treatment utilizing the lateral approach and simultaneous implant placement, were observed for a period of 4 to 5 years. The mean follow-up period was 4.86 years. The mean age of the patients was 47.61 years. The distribution of the implants placed simultaneously with the sinus floor elevation is shown on Figure 5 by region of placement.

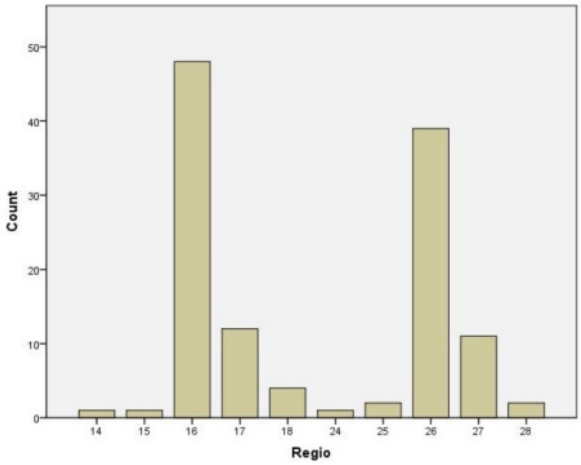

Figure 5. The distribution of implants placed simultaneously with sinus floor elevation by region of placement (according to FDI).

The most common location was the upper sixth teeth, for 16 the total number of the procedures was 39.7%, and for 26 -32.2%. Depending on the height of the residual subantral bone, the results were as follows: the mean height of residual bone is 3.054 mm - Figure 6.

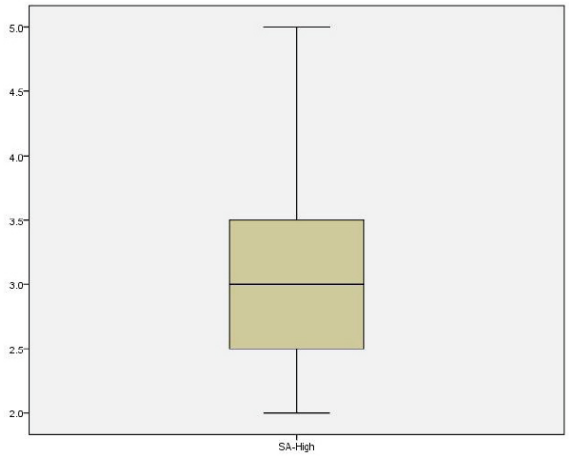

Figure 6. A boxplot of the descriptive analysis of the data for the height of the residual subantral bone in millimeters of cases indicated for sinus floor elevation with simultaneous implant placement.

The mean height of the subantral bone in cases where the implants were loaded four months after the procedure was 3.44 mm and when they were loaded five months after the procedure – 2.557 mm. In 19% of the cases marginal bone resorption was found. Bleeding on probing was registered in 14.9% of the cases. The mean resorption for all cases was 0.174 mm. The survival rate of the implants placed simultaneously with sinus floor elevation utilizing the lateral approach for the observation period is 99.2%. In 86% of the cases there were no intraoperative and postoperative complications. In 10.7% of the cases perforation of the sinus membrane occurred intraoperatively, which was solved using a "patch" of

pericardial collagen membrane. In 3.3% of the cases perforation of the sinus membrane occurred, which was sutured with resorbable polyfilament suture material. The total frequency of intraoperative complications was 14%. None of the cases necessitated postponement of the procedure due to intraoperative complications. There weren't any postoperative complications requiring special treatment.

Sinus floor elevation and staged implant placement.

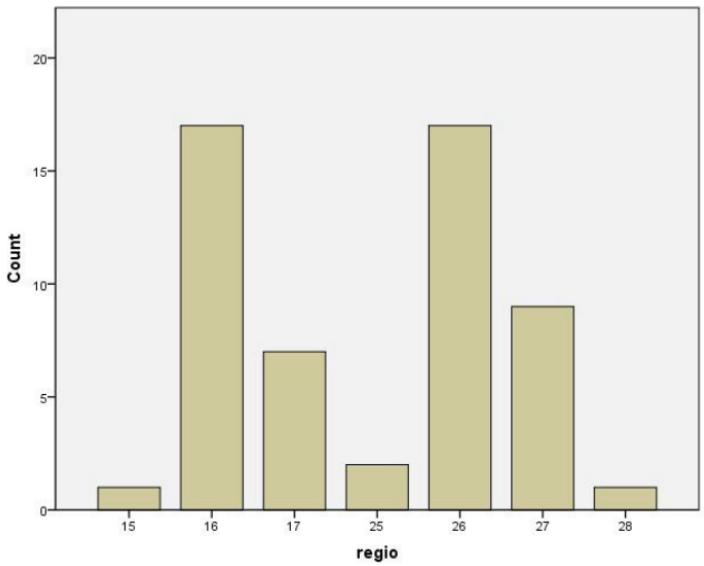

Figure 7. The distribution of staged implants placed after sinus floor elevation by region of placement (according to FDI).

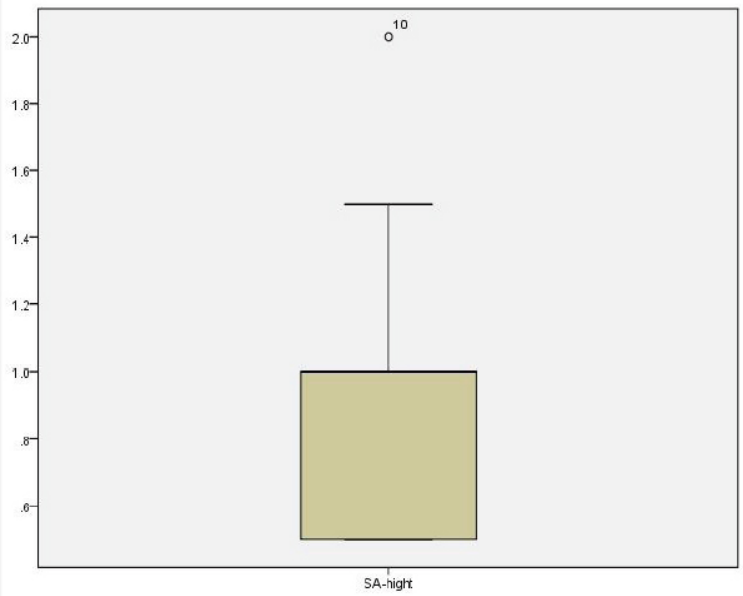

Figure 8. A boxplot of the descriptive analysis of the data for the height of the residual subantral bone in millimeters.

Patients who were treated with sinus floor elevation utilizing the lateral approach and stage implant placement were observed for a period of 4 to 5 years. The mean follow-up period was 4.85 years. The distribution of the patients by gender was as follows: 46.3-women and 53.7-men. The mean age of the patients is 55.22 years. The distribution of the implants placed simultaneously with sinus floor elevation by region of placement is shown on Figure 7.

The most common locations were: 16 - 31.5%, 26 - 31.5%, 27 - 16.7%, 17 -13%. The mean height of the residual bone was 1mm - Figure 8.

The mean time for stage implant placement after sinus floor elevation was 5,28 months after the subantral bone augmentation (the minimum time was 5 months, and the maximum - 8 months).The mean required time before the implants were loaded was 6 months. The survival rate for the implants was 100% for the observation period. The mean marginal bone loss was 0,167mm. Marginal bone loss was found in 20.4% of the cases. Bleeding on probing was registered in 13% of the cases. In 90.7% from the cases there weren't any intraoperative and postoperative complications. In 7.4% of the cases perforation of the sinus membrane occurred intraoperatively, which was treated using a "patch" of pericardial collagen membrane. In 1.9% of the cases was found perforation of the sinus membrane, which was sutured with resorbable polyfilament suture material. The total frequency of intraoperative complications was 9.3%. None of the cases necessitated postponement of the procedure due to intraoperative complications. There were no postoperative complications requiring special treatment.

Discussion

The sinus floor elevation utilizing the lateral approach and simultaneous or stage implant placement demonstrate high success rate of the augmentation procedures and high survival rate of the implants according to our study. Our research confirms the results reported by Lundgren et al. (9), Zitzmann Schärer (10), Mazor et al. (7) Peleg et al. (11), van den Bergh et al. (12) and others. Straumann Bone Level implants placed simultaneously with the sinus floor elevation utilizing the lateral approach were placed successfully at a height of the residual subantral bone from 2 to 5 mm. The mean height of the residual subantral bone was 3.045 mm. When the sinus floor elevation utilizing the lateral approach was performed with stage implant placement, then the height of the residual subantral bone was below 2 mm. The implants placed simultaneously with the sinus floor elevation utilizing the lateral approach were functionally loaded between the fourth and the fifth month after the procedure, according to the height of the residual bone. Obviously at that time the tissues at the augmented sinus floor provide a sufficient support for implants to bear function loading. In the literature there are few reports of such a short consolidation period (12,13). The mean marginal bone resorption for both methods is similar - 0,174mm for procedures with simultaneous implant placement and 0,167mm for the method with stage implant placement. Both methods demonstrated high predictability. Intraoperative complications were registered in 7.4% up to 11% from the cases, all of which were solved relatively easily during the surgery. In 1.9% up to 3% from the cases the complications required high qualification and skills for their resolution. For that reason some alternative treatment modalities could be discussed (14). There is no influence of the type of the used grafting material on the results.

Conclusion

Sinus floor elevation utilizing the lateral approach and simultaneous implant placement performed in keeping with our methodology show high success rate of the augmentation procedures and survival rate of 99.2% for the implants. 2 to 5 millimeters of residual bone height is enough to provide a sufficient primary stability with used implants (Straumann Bone Level Implants) in order to ensure the high success rate of the procedure. The implants were functionally loaded 5 months after the procedure. Sinus floor elevation utilizing the lateral approach and stage implant placement performed according to the described method demonstrate a high success rate of the augmentation procedures and 100% survival rate of the implants. The type of bone-grafting material doesn't affect the results.

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