Open Sinus Lift Healing Comparison between a Non-Perforated Schneiderian Membrane and a Perforated Schneiderian Membrane Repaired with Amnion-Chorion Allograft Barrier: A Controlled, Split Mouth Case Report

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Abstract

Background: Schneiderian membrane perforation is the most common complication of maxillary sinus augmentation and has been associated with a variety of post-surgical problems including infections, failed grafts, and grafts of inadequate magnitude to facilitate the placement of dental implants. The effects of perforated Schneiderian membranes can be somewhat mitigated through repair with a variety of different membrane materials. A number of studies have presented data comparing dental implant success with repaired Schneiderian membranes to non-perforated membranes, but no studies have shown a direct split-mouth comparison within a single subject. The following Case Report shows a single patient who received bilateral maxillary sinus lifts in which one side was unintentionally perforated and repaired with amnion-chorion barrier while the other side was non-perforated. Complications, implant survival, clinical, and radiographic healing comparisons are presented and discussed.

Methods: In a single patient, bilateral maxillary sinus lifts were performed via the lateral window method. Both sinuses were treated in the same exact fashion. During instrumentation for sinus membrane elevation, the right sinus membrane was unintentionally perforated and repaired with an amnion-chorion barrier while the left sinus membrane was not perforated. Both sinuses were then grafted with a combination of bone xenograft/allograft and the lateral windows were covered with amnion-chorion membranes. After four months of healing, a cone beam computed tomography scan was utilized to assess the results of healing and plan a guided dental implant surgery. Following placement of dental implants, the case was immediately loaded with a transitional prosthesis for four months and ultimately restored with a zirconia restoration.

Results: The non-perforated sinus lift healed with more bone height and a denser, more uniform fill compared to the sinus lift repaired with amnion-chorion barrier. Both sides, however, had adequate healing to permit placement of multiple dental implants to support an immediately loaded restoration. After two years of function, implants in both sinuses have demonstrated zero complications and the prosthesis is functioning well.

Conclusions: This is the first known study to document direct healing comparisons between a repaired perforated maxillary sinus membrane versus a non-perforated sinus membrane when sinus augmentations were performed in the same person at the same time. Amnion-chorion barriers have unique properties that make them ideal for repair of perforated maxillary sinus membranes. This direct split mouth comparison Case Report demonstrates that these barriers can produce healing results that allow for long term functioning of dental implants without complication.

KEY WORDS: Maxillary sinus, sinus floor augmentation, nasal mucosa, dental implants, amnion, chorion

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Figure 1: Presurgical CBCT scan of patient showing bilateral pneumatized maxillary sinuses and severe bone loss secondary to periodontal disease.

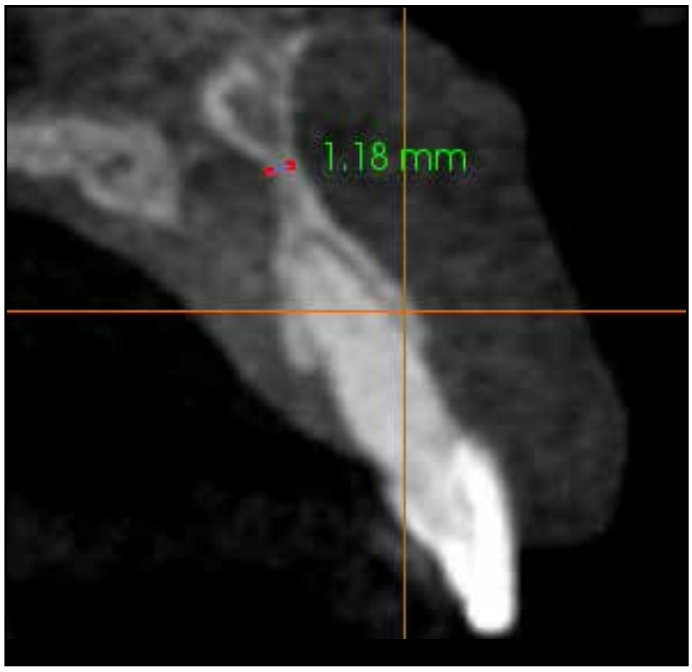

Figure 2: Presurgical CBCT scan showing minimal bone thickness in the maxillary anterior sextant.

INTRODUCTION

Pneumatization of the maxillary sinus is a common finding with edentulism of the posterior maxilla and often requires augmentation to facilitate the placement of dental implants.[1] Perforation of the Schneiderian membrane is the most common complication associated with maxillary sinus augmentation procedures[2] with rates ranging from 11% to 56%.[3,4] Multiple techniques have been presented in dental literature for repair of perforated sinus membranes including the use of palatal flaps,[5] buccal fat pads,[6] Lambone,[7] specialized suturing techniques,[8] and fixed membrane pouches.[9,10] With excessively large perforations, however, reparative techniques are sometimes not feasibly and the procedure must be aborted. When sinus membrane repair is achievable, these studies, and multiple other conformational studies,[11-13] show that perforation and subsequent repair of the Schneiderian membrane does not compromise the final success of dental implant survival. None of these studies[5-13] however, show any cases with direct split-mouth intrapatient healing comparisons of repaired perforated sinus membranes versus non-perforated sinus membranes. This Case Report presents a situation in which a patient receiving bilateral maxillary sinus lifts had perforation and repair of one sinus membrane while the other side remained intact. With these sinus lifts being performed in the same patient at the exact same time, a unique opportunity presented itself for direct observation and comparison of healing results for a repaired versus a non-perforated sinus lift and the dental implant survival that followed.

METHODS

A 52 year old Caucasian female was referred to our periodontal specialty clinic for evaluation and treatment of long standing chronic periodontal disease. Over the past fifteen years, the patient had undergone a variety of procedures to treat her

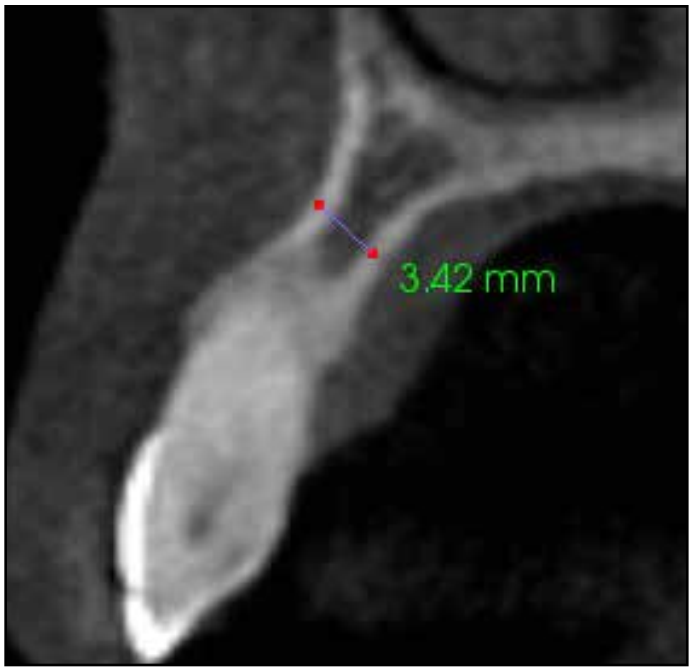

Figure 3: **Presurgical CBCT scan (alternate view) showing minimal bone thickness in the maxillary anterior sextant.**

condition including non-surgical scaling and root planing, open flap debridement, bone grafting with guided tissue regeneration, and three month periodontal maintenance. In spite of these efforts and the patient's meticulous home oral hygiene measures, she continued to have pocket depths ranging from 2-8mm with excessive mobility in many of her teeth, particularly in the maxilla. Although the mandible demonstrated moderate to severe horizontal bone loss from her past history of periodontal disease and surgical procedures, probing depths in this arch only ranged from 2-5mm and tooth mobility, although present, was not as significant as that seen in the maxilla. The patient was frustrated with the continued deterioration of her periodontal condition, the esthetics of her maxillary teeth, and her inability to eat many foods due to the excessive mobility of her maxillary teeth. After discussing multiple treatment options with the patient, she requested to have dental implant restoration of her maxillary arch. While it would have been more ideal to treat both the maxillary and mandibular arches simultaneously, the patient elected for treatment of only the maxillary arch. The patient did express that she would like to have the mandibular arch treated in a similar fashion to the maxilla in the future when her finances permitted.

To accommodate the patient's desires for a dental implant supported fixed restoration of the maxilla, the patient's significant bone deficiencies had to be addressed. A cone beam computed tomography (CBCT) scan revealed that the patient not only had significantly pneumatized maxillary sinuses bilaterally (Figure 1), she also had minimal bone height and width in the anterior maxillary sextant (Figures 2, 3). Because of these findings, it was decided that bilateral maxillary open sinus lifts would be performed to gain as much bone height as possible in the posterior and mid maxilla. Once these bone augmentations healed, the patient would receive an additional CBCT scan and a guided dental implant surgery would be planned with at least 3-4 dental implants being placed into each augmented sinus.

The first procedure involved extraction/site preservation of teeth 2, 3, 4, 13, 14, and 15 with simultaneous bilateral maxillary sinus lifts. Because these sinus augmentations were going to heal for at least 4-5 months prior to the second surgical phase, teeth 5-12 were left in place at the patient's request to "give me something to smile and chew with while everything is healing." Although the option of a temporary complete denture was offered to the patient, she declined noting that she did not want to wear any removable prostheses at any time during her treatment. Following the administration of local anesthesia

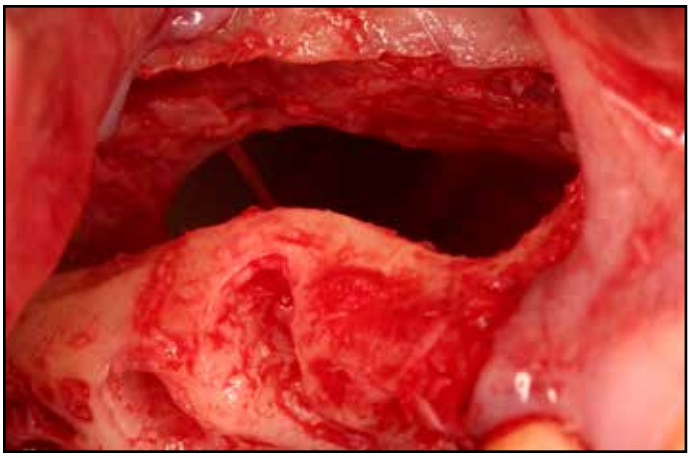

Figure 4: Large perforation of Schneiderian membrane in the right maxillary sinus.

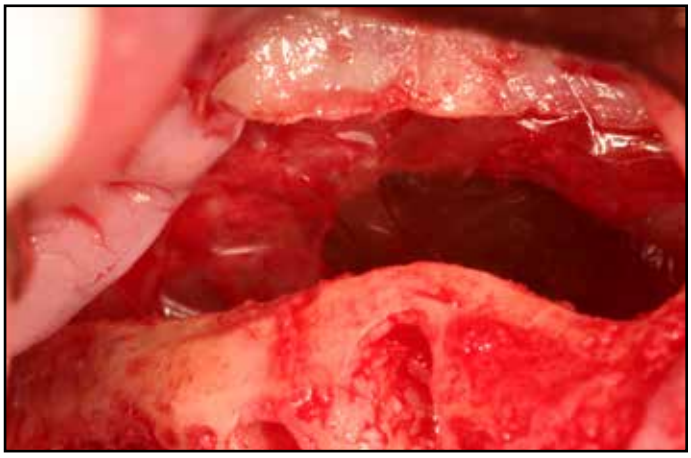

Figure 5: Amnion-Chorion barrier placed onto sinus membrane perforation. Note that no stabilizing sutures are required as the barrier self-adheres to the Schneiderian membrane.

Figure 6: Placement of bone xenograft/allograft combination into the maxillary sinus and extraction sockets.

Figure 7: Amnion-Chorion barrier used to cover the lateral access window and grafted sockets.

and intravenous conscious sedation, full thickness mucoperiosteal flaps were elevated bilaterally and teeth 2, 3, 4, 13, 14, and 15 were elevated/extracted. Following removal of these teeth, all sockets were degranulated with hand instruments and sharp bony spurs were recontoured with a rotary bur. For the sinus lift procedures, a piezoelectric hand piece (DoWell Dental, California, USA) was utilized to create a lateral window into both the left and right maxillary sinuses. Next, piezoelectric sinus elevation tips were utilized to begin elevation of the Schneiderian membranes. After initial mobility of the Schneiderian membranes were achieved, hand instrumentation was used to perform the remainder of the sinus membrane elevation. While the left Schneiderian

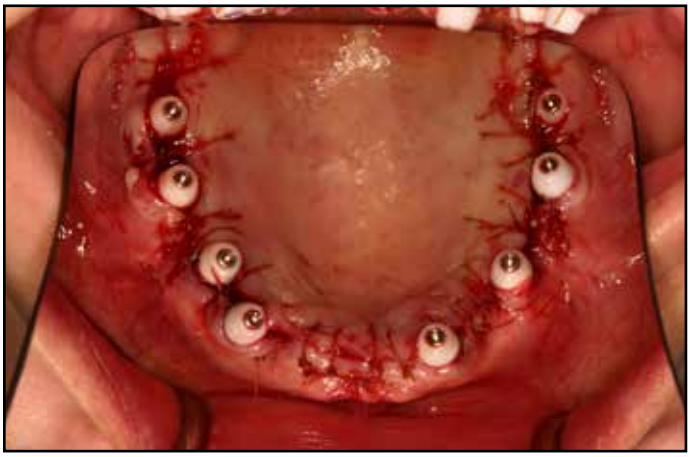

Figure 8: Placement of eight dental implants with multi-unit abutments and white healing caps.

Figure 9: Immediately loaded maxillary transitional prosthesis.

Figure 10: Final zirconia restoration prior to delivery.

Figure 11: Final zirconia restoration after delivery.

membrane was elevated without complication, a large perforation occurred (Figure 4) during elevation of the right sinus membrane. To repair the sinus membrane perforation, a large piece of amnion-chorion barrier (BioXclude, Snoasis Medical, Denver, Colorado, USA) was placed directly onto the Schneiderian membrane (Figure 5). Care was taken to make sure that the amnion-chorion barrier completely covered the sinus membrane perforation with extension of the barrier at least 3mm beyond the lateral borders of the defect. The amnion-chorion barrier was initially placed into the maxillary sinus dry (non-hydrated) which allowed for easy manipulation and movement of the barrier. Once placed into the desired position, the patient's own blood was utilized to hydrate

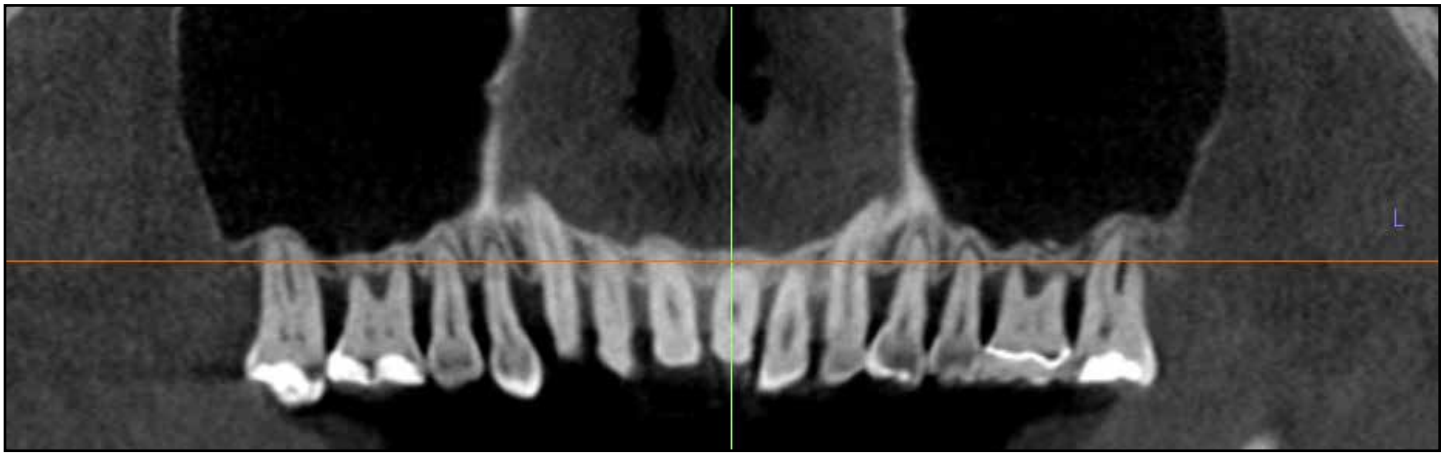

Figure 12: Presurgical CBCT scan prior to maxillary sinus augmentations (coronal view).

Figure 13: Postsurgical CBCT scan after maxillary sinus augmentations (coronal view).

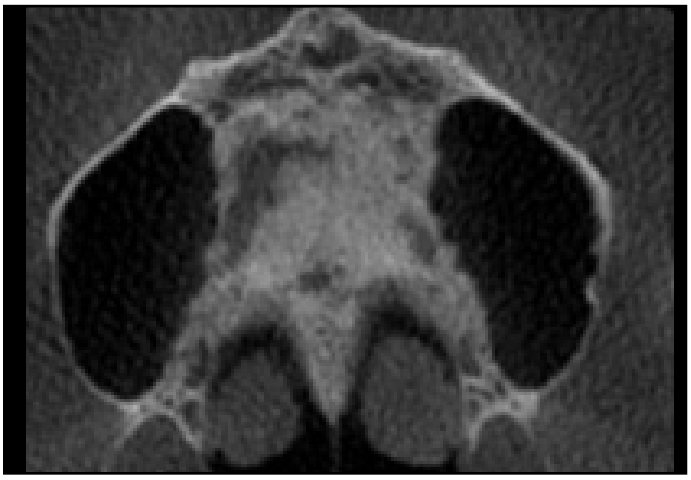

Figure 14: Presurgical CBCT scan prior to maxillary sinus augmentations (transverse view).

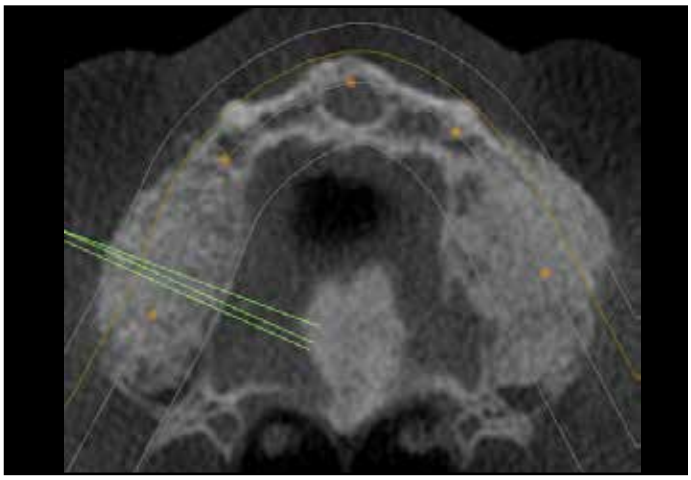

Figure 15: Postsurgical CBCT scan after maxillary sinus augmentations (transverse view).

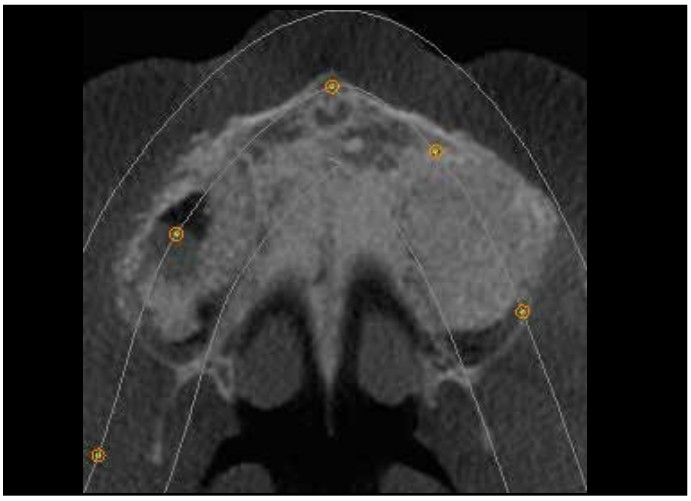

Figure 16: Postsurgical CBCT scan after maxillary sinus augmentation (transverse view) showing radiolucent area in the right sinus where Schneiderian membrane perforation occurred.

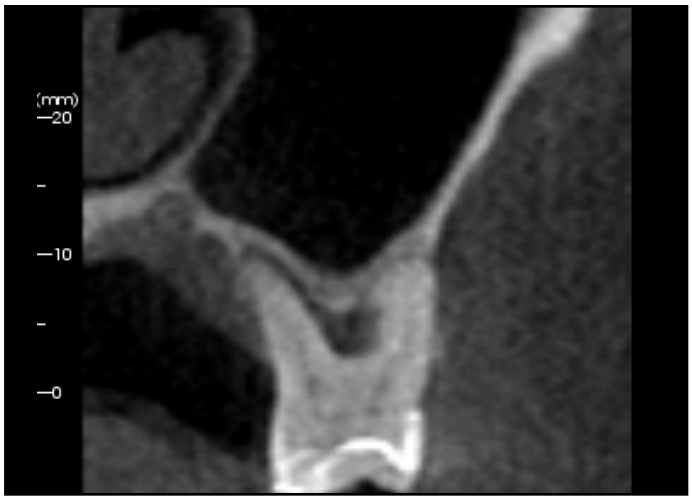

Figure 17: Presurgical CBCT scan of left maxillary sinus showing sinus pneumatization.

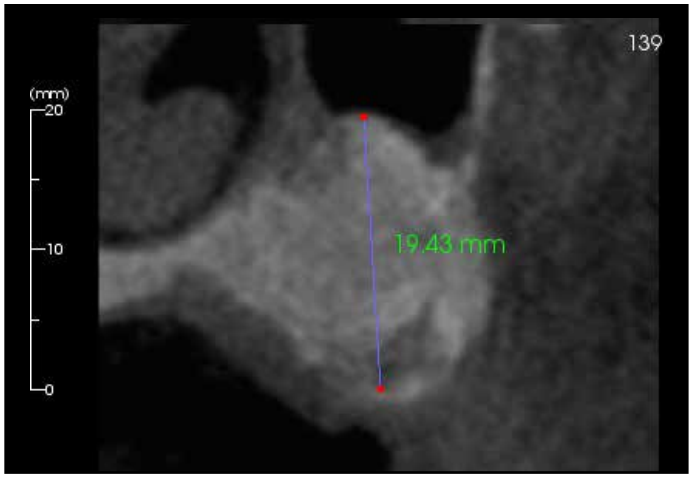

Figure 18: Postsurgical CBCT scan of the left maxillary sinus showing bone fill at 120 days.

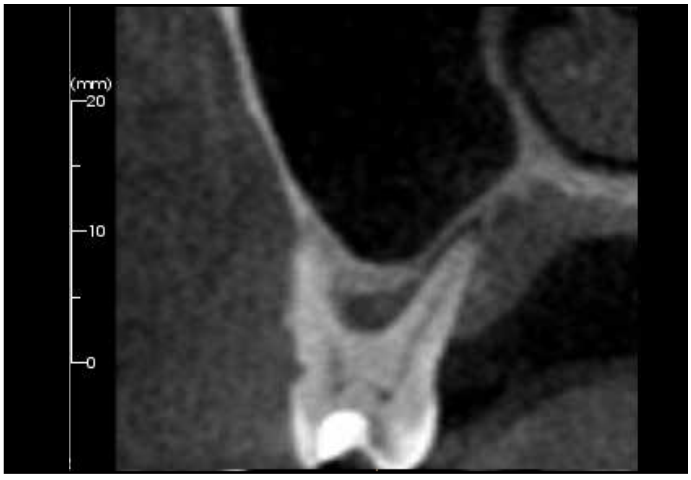

Figure 19: Presurgical CBCT scan of right maxillary sinus showing sinus pneumatization.

the amnion-chorion barrier. Upon hydration, the amnion-chorion barrier became very tacky and self-adhered to the Schneiderian membrane, thus eliminating any need for stabilizing sutures. Following repair of the perforated sinus membrane, a mixture of bone xenograft (Bio-Oss, Geistlich Pharma North America, Princeton, New Jersey, USA) and bone allograft (Maxxeus, Dallas, Texas, USA) was placed into the sinus cavity (Figure 6) and the lateral windows were covered (Figure 7) with amnion-chorion barriers (BioXclude, Snoasis Medical, Denver, Colorado, USA). The mucoperiosteal flaps were then reapproximated with 4-0 polytetrafluoroethylene sutures. Post-surgically,

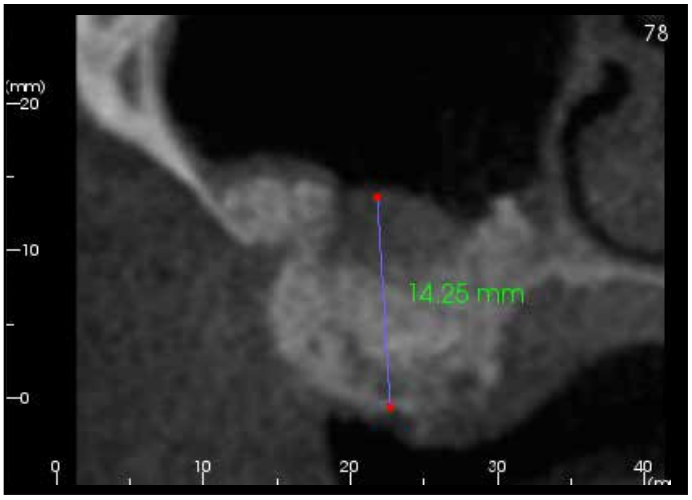

Figure 20: Postsurgical CBCT scan of the right maxillary sinus showing bone fill at 120 days.

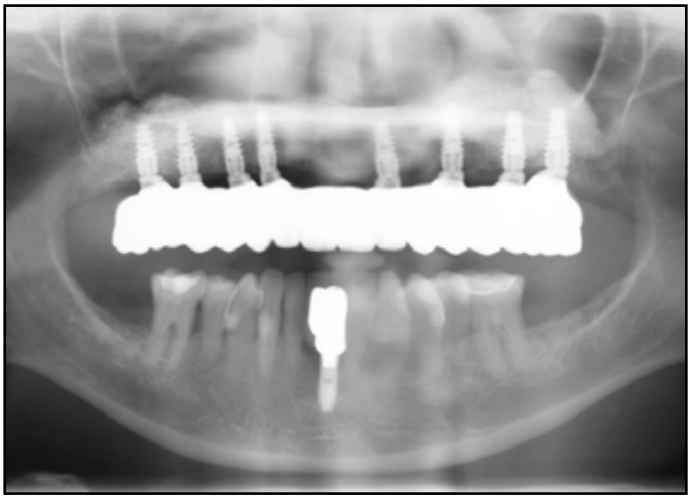

Figure 21: Radiograph of dental implants and final restoration immediately after initial delivery.

Figure 22: Final restoration after 2 years in function (extraoral view).

Figure 23: Final restoration after 2 years in function (intraoral view).

the patient was prescribed pain medications, antibiotics, and steroids. The patient was seen for follow-up visits at 10, 21, 42, 90, and 120 days.

After 120 days of uneventful healing, the patient was sent for a CBCT scan. The CBCT scan was evaluated for healing of the bilateral sinus augmentations and a guided surgical stent was planned (NobelGuide™, Nobel Biocare, Yorba Linda, California, USA). The second surgi-

Figure 24: Radiograph of dental implants and final restoration after 2 years of function.

cal procedure was carried out 150 days after the original surgical procedure. Following the administration of local anesthesia and intravenous conscious sedation, all remaining maxillary teeth were extracted and the surgical guide was affixed with three strategically placed pins. A total of 8 dental implants (NobelActive, Nobel Biocare, Yorba Linda, California, USA) were placed utilizing the surgical guide. Following removal of the guide, multi-unit healing abutments were placed on all implants with 15 Ncm of torque and white healing caps were screwed into the abutments (Figure 8). The patient was then released to the prosthodontist who adjusted and delivered an immediately loaded full-arch transitional prosthesis (Figure 9). The patient wore the transitional prosthesis for four months and then received a zirconia final restoration (Figures 10, 11).

RESULTS

The patient healed uneventfully and reported no differences in pain or other symptoms between the two sinuses. The CBCT scan taken at 120 days was compared to the pre-surgical CBCT scan for healing evaluation and comparison of the non-perforated augmented sinus versus the perforated repaired augmented sinus. In general, the non-perforated sinus showed a more dense bone fill compared to the repaired perforated side (Figures 12-15). When the area of the repaired sinus membrane perforation was examined in a transverse view via the CBCT scan, a well-defined radiolucent area was clearly visible (Figure 16). The non-perforated sinus had more bone fill vertically than the repaired perforated side (Figures 17-20). Although the repaired sinus did not achieve bone fill as robust or dense as the non-perforated side, adequate bone was still present for the placement of dental implants which were 11.5mm in length (Figure 21). All dental implants achieved at least 35 Ncm of torque at placement and allowed for immediate loading of a transitional prosthesis. The transitional prosthesis was placed in function for a total of four months without complication prior to the fabrication and delivery of a zirconia final restoration. After two years in function with the zirconia restoration, the patient has experienced no complications (Figures 22, 23). Comparisons of bone levels around the dental implants after two years in function revealed no difference in bone loss between the repaired perforated side versus the non-perforated side (Figure 24).

DISCUSSION

Multiple studies have demonstrated that it is possible to repair perforated maxillary sinus membranes and still achieve later success with dental implants.[5-10] These studies base their conclusions on success comparing perforated versus

non-perforated cases in different individuals. While these studies demonstrate that repaired perforated sinus membranes do allow for dental implant success in augmented sinuses, they do not show direct healing comparisons to non-perforated membranes. Do non-perforated sinuses heal with more bone than repaired perforated sinuses? Do non-perforated sinuses heal with denser bone fills than repaired perforated sinuses? The present case report is unique because it shows direct split mouth healing comparisons in the same person with procedures performed at the exact same time. Additionally, this study is unique in the fact that it shows repair of a perforated Schneiderian membrane with an amnion-chorion barrier. To the author's knowledge, this is the first study to demonstrate repair of a sinus membrane with such a material.

Amnion-chorion barriers inherently possess a number of unique properties that make them suitable candidates for repair of sinus membrane perforations. First and foremost, amnion-chorion barriers are extremely thin averaging approximately 300 µm in cross sectional thickness[14] compared to Schneiderian membranes that can average as little as 800µm in thickness.[17] The thin nature of amnion-chorion barriers makes them easy to place into tight maxillary sinuses and their self-adherent properties upon hydration eliminates the need for stabilization with sutures[8] or tacks[9,10] as is required with previously published methods. Additionally, the translucency of amnion-chorion barriers makes it easy to see if the sinus membrane perforation has been completely covered (Figure 5). Amnion-chorion barriers also contain a variety of proteins including collagen types I, III, IV, V, and VI, laminin-5, platelet-derived growth factor-a (PDGF-a), PDGF-b, fibroblast growth factor; and transforming growth factor-b that help to facilitate wound healing.[18] A recently published study utilizing amnion-chorion barriers for guided tissue regeneration of periodontal defects noted rapid epithelial granulation coverage of exposed graft material[14] while an additional study in which amnion-chorion barriers were intentionally left exposed to the oral cavity showed similar findings of rapid epithelial granulation formation over graft material.[15] Both of these studies suggest that the various proteins found in amnion-chorion barriers, Laminin-5 in particular, may be responsible for this rapid epithelial granulation formation. Laminin-5 is an extracellular matrix component prominent in basement membranes and has been shown to stimulate epithelial cell migration.[19] Immunohistochemical analysis of amnion-chorion barriers used for dental applications such as those published for guided tissue regeneration and extraction site preservation have shown extremely high concentrations of Laminin-5.[20] It is possible that the high concentration of Laminin-5 found in amnion-chorion barriers is contributing factor to the rapid epithelial granulation formation seen with the previously published guided tissue regeneration and extraction site preservation studies. As the Schneiderian membrane is epithelial in nature, repair of perforations in this membrane via amnion-chorion barriers provides a bioactive matrix substrate across which epithelial cells of the host sinus membrane may rapidly migrate across.

CONCLUSIONS

While repaired perforated Schneiderian membranes do allow for successful placement and ultimate survival of dental implants, bone fill and bone density in these augmented sinuses do not appear to be as robust as that which is seen in non-perfo-

rated maxillary sinuses. Although the quantity and quality of bone in non-perforated augmented maxillary sinuses appears to be superior to that which is seen in repaired perforated augmented maxillary sinuses, implant success does not appear to differ between the two. In the end, dental implant survival is the true measure of success as the goal of the surgery is long term surviving dental implants. Finally, this case report demonstrates that amnion-chorion barriers are uniquely suited for the repair of perforated maxillary sinus membranes.

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Disclosure
Dr. Holtzclaw is on the Clinical Advisory Board of Snoasis Medical and has a financial interest in the company.

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