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Comparative Analysis of PTFE and Amniotic Tissue Membranes for Alveolar Ridge Preservation After Tooth Extraction

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Abstract: ***This study compares the efficacy of PTFE and amniotic tissue membranes in preserving the alveolar ridge following tooth extraction, with the aim of minimizing additional surgeries and enhancing patient outcomes. A randomized trial involving 28 patients assessed ridge preservation using freeze-dried bone allografts covered by either PTFE or amniotic membranes. CBCT scans conducted four months post-operatively revealed bone loss in both groups, with PTFE showing slightly better preservation at the crest. The vertical bone changes were negligible. While both materials demonstrated effectiveness, the study highlights the necessity of unbiased comparative research to support clinical decision-making and recommends further studies incorporating site-specific analysis and patient feedback. Aim: To compare the effectiveness of PTFE and amniotic tissue membranes in preserving the alveolar ridge after tooth extraction, focusing on reducing additional surgeries and improving patient outcomes. Materials and Methods: This randomized trial included patients needing tooth extraction and potential dental implants. Patients were randomly assigned to two groups: one using an amniotic membrane and allograft, the other using a Cytoplast membrane and allograft. Post-extraction, sockets were filled with freeze-dried bone allograft and covered with the respective membranes. Follow-up visits and CBCT scans were conducted for analysis. Results: CBCT scans four months post-treatment showed significant bone loss in both groups. The dPTFE group had a crestal loss of 5.60 mm, 4.05 mm at 2 mm, and 1.80 mm at 4 mm. The amniotic tissue membrane group had a crestal loss of 9.53 mm, 5.69 mm at 2 mm, and 1.20 mm at 4 mm. Significant difference at the crest, with Cytoplast showing 7.05 mm loss and Neomem-Xac showing 8.95 mm loss. Vertical changes were minimal and not significantly different. Conclusion: This study aims to directly compare PTFE and amniotic tissue membranes for their effectiveness in maintaining alveolar ridge dimensions post-extraction Both PTFE and amniotic tissue membranes were effective in alveolar ridge preservation. The only significant difference was at the crest. The study emphasizes the need for unbiased, direct comparisons of dental materials to guide clinicians in making informed decisions. Future research should include position-specific evaluations and patient feedback.***

Keywords: alveolar ridge preservation, PTFE membrane, amniotic tissue membrane, bone graft, dental implant surgery

1. Introduction

Tooth
loss continues to be a major concern in dentistry, impacting mi llions each year and presenting difficulties for proper oral functions that depend on preserving sufficient bone and soft tissue support. Although progress in dental technology and methods has broadened the choices for tooth replacement, having sufficient bone at the treatment location is still crucial for achieving successful results. Regrettably, loss of alveolar bone after tooth extraction is a prevalent issue that can significantly affect the viability of restorative treatments.

Alveolar ridge preservation (ARP) methods are used to reduce the negative effects of tooth removal by keeping the bone structure of the alveolar ridge intact. This is important because significant bone loss usually happens in the first six months after a tooth is removed. Studies have found that vertical bone loss can range from 11-22% within the first six months post-extraction. Additionally, horizontal bone loss can reach up to 63% during the same period. This loss of bone width and height can make it harder to restore the area or may require additional augmentation procedures to restore the lost bone.

In recent years, different materials and methods have been created to improve the results of ARP (alveolar ridge preservation). High-density PTFE is a synthetic material known for being biocompatible for the body, resistant to chemicals, and effective at stopping tissue from growing over the healing area. This helps in preserving the healing site for bone regeneration. Another option is amniotic tissue membranes, which come from human placental tissue. These membranes are rich in growth factors that help tissues heal and regenerate. These membranes also eliminate the need for primary closure, allowing secondary intention healing and the maintenance of the periosteum, which is important for bone preservation.

This study aims to compare how well PTFE and amniotic tissue membranes work in preserving the alveolar ridge after tooth extraction. It focuses on how these materials help maintain the width and height of the ridge. By looking at the characteristics and performance of these materials, the research wants to find out which one is better at providing reliable and good results for socket preservation. It also aims to understand the clinical importance of these materials, especially in reducing the need for additional surgeries and improving the patient experience by minimizing pain and improving surgical results.

2. Materials and Methods

Patient Selection

This study was a prospective and randomized human trial that involved patients who needed tooth extraction and might need a dental implant later. After a detailed check-up and once it was confirmed that a tooth was non-salvageable, patients were asked if they wanted to participate in the study. All patients who met the requirements during the study period were asked to participate. Those who agreed signed consent forms and were given a random number to keep the study fair and unbiased. These patients were then included in the trial. Before the tooth was removed, basic information about the patients was recorded. This included the thickness of the buccal bone (classified as thick or thin), residual buccal plate thickness at the crest, and residual ridge width at the crest.

Patients underwent CBCT imaging (Pax-i3D Smart, Vatech, Hwaseong, Korea) before surgery. The resulting data were retrieved, converted to DICOM (Digital Imaging and Communications in Medicine) format, and imported into open-source software for 3D image processing.

Subjects were excluded if they had one or more of the following: (i) a history of systemic disease that would contraindicate oral surgical treatment; (ii) patients younger than 18 years old; (iii) long-term nonsteroidal anti-inflammatory drug therapy exceeding 100 mg daily; (iv) pregnant or lactating women.

Further, the subjects were randomly assigned into two groups. The first group underwent ridge preservation using an amniotic membrane with allograft material. The second group underwent ridge preservation using a Cytoplast membrane with allograft material.

3. Surgical Procedure

After numbing the area with local anaesthesia, the teeth were carefully and gently removed with minimal trauma. Surgical forceps were used to extract the teeth, making sure not to put too much pressure on the bone around the teeth. For teeth with multiple roots, a fine straight bur was used to cut them into sections before removal. After the teeth were removed, the sockets were cleaned, and full-thickness mucoperiosteal envelope flaps were reflected to allow access approximately 10 mm apical on the buccal ridge and approximately 5 mm on the lingual ridge for membrane positioning. Freeze-dried bone allograft (FDBA) (~250-1000 microns; Osteoss Powder) was placed in the socket. Then a membrane (chosen based on the group the patient was in) was placed over the bone graft, extending 10 mm on the buccal side and 5 mm on the lingual side.

When using dPTFE membranes (Cytoplast, TXT1224, 12x24; Osteogenics Biomedical, Lubbock, TX), the membranes were trimmed to cover the socket but kept at least 1 mm away from the nearby tooth. An amniotic tissue membrane (Citagenix Neomem XAC – Amnion Chorion Membrane) was adjusted and folded as needed to cover the area. A continuous Ethicon propylene 5-0 suture was used to secure the wound, with two additional interrupted sutures placed at the mesial and distal of the gum. Patients were given amoxicillin and told to rinse their mouth with 0.2% chlorhexidine twice a day for two weeks. Ibuprofen was provided to help with pain and swelling after the surgery. For patients allergic to amoxicillin, cephalexin was prescribed instead.

Patients were asked to come back for check-ups at 1, 2, and 4 weeks after surgery. The doctor filled out a form to assess how the surgery went. At the 1-week visit, the doctor checked on the patient to help with any pain or discomfort. The stitches were taken out 14 days after the surgery. After 4 weeks, the dPTFE membrane was removed, but the amniotic tissue membrane (BioXclude) did not need to be taken out. Removing the dPTFE (Cytoplast) was not very painful and didn't require anesthesia. Around four months later, an assessment was completed including a 3D scan (CBCT) to evaluate whether the area where the tooth was removed was healing.

4. Data Analysis

Four months after the treatment, a final CBCT scan was done and saved in DICOM format (a standard for medical images). These files were then uploaded into 3D imaging software (Dolphin Imaging and Management Solutions, Chatsworth, CA) for review. Using this software, the CBCT images taken before the tooth removal and the ones taken after four months of healing were matched and overlaid to compare them directly. This matching was done by finding the same fixed points in the anatomy.

Subtraction radiography was conducted on the superimposed images to evaluate changes in the alveolar ridge. Measurements were taken at three levels: the crest of the alveolar ridge and 2 mm and 4 mm below the crest. Vertical measurements were also recorded to assess any bone loss in the vertical dimension.

The following parameters were analyzed:

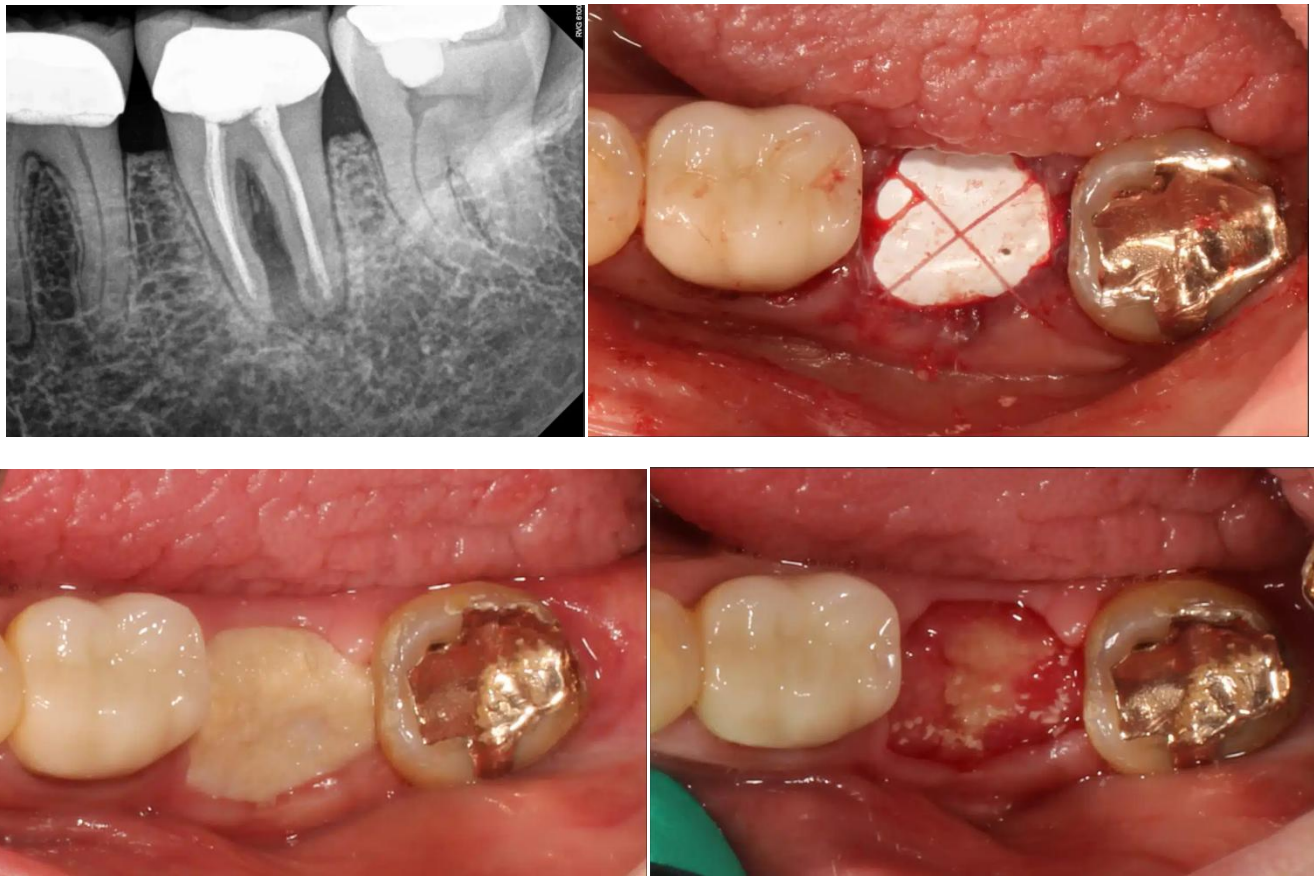
1) The percentage change in baseline alveolar ridge dimensions, both horizontally and vertically.
2) B-L ridge width as measured at mid-extraction socket
3) Cortical bone thickness.

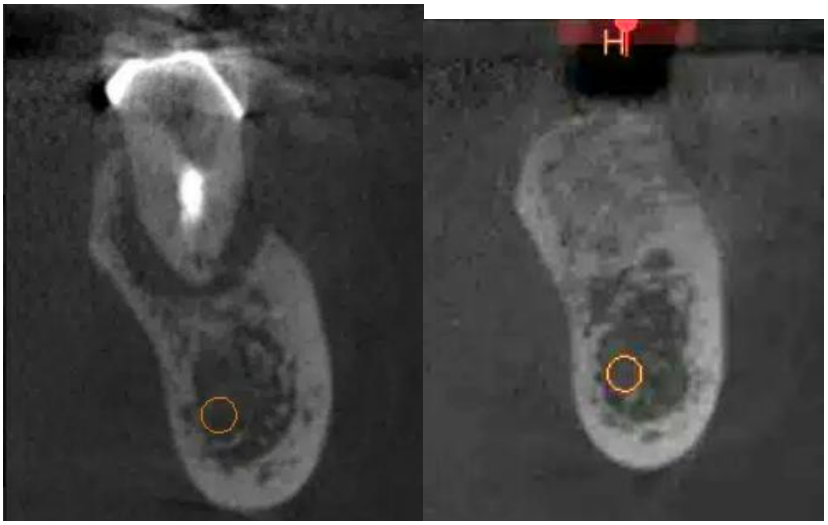
5. Results

It was decided that Dolphin 3D software could complete with high accuracy the superimposition of the two images and subtraction radiography could be completed. The baseline and post extraction (4 mos) CBCT files (DICOM) were downloaded into Dolphin 3D for analysis of bone volume change. The post extraction image was superimposed over the initial scan using 3 similar anatomic points (cusp tips, foramen, CEJ, and restorations) as well as the software image overlay function. This function utilized the surrounding

anatomy of the two images in processing the overlay. The accuracy of this superimposition was due to the high resolution of the scans allowing for easy point identification. The investigator was then able to toggle between the two 23 images and see the differences at the extraction site. The initial scans were measured in horizontal planes and then toggled to the final scans for similar measurements as well as a vertical change. The alternate investigator would take an independent set of measurements averaged the measurements taken at crest, 2 mm and 4 mm. In total 28 patients were measured but 4 patients dropped out of the study leaving 24 patients used for measurement purposes. All groups showed loss in one or both directions. For statistical purposes, the median loss was used because the data was not normally distributed. In the DPTFE group, the crestal loss was 5.60 mm, at 2 mm the loss was 4.05 mm, and at 4 mm, the loss was 1.80 mm. The Amniotic tissue membrane group, showed loss at the crest of 9.53 mm, at 2 mm the loss was 5.69 mm, and at 4 mm the loss was 1.20 mm. In direct comparison of the products, regardless of technique, the only statistically significant finding was at the crest where the median loss for Cytoplast was 7.05 mm and Neomem- Xac was 8.95 mm. While found to be statistically significant, it should be viewed with caution due to low sample size. All other findings showed significant reduction from baseline, but the median decreases were not seen as significant. The vertical changes were 0.47 mm for Cytoplast and 0.39 mm for Neomem- Xac, but these were noted to be not significantly different from zero or from each other. 24 Since the data deviated from normality and other assumptions needed for parametric testing were not met, non-parametric tests were used to assess whether the differences were significant. The statistics were completed not assuming normality or normal distribution. This was most likely due to the small sample group. In the first 27 patients to been treated, no adverse events were noted and three dropouts occurred. One patient moved unexpectedly, one retired from the military, and one was removed from the study due to non-compliance with appointment dates. Overall, patient scheduling and compliance were sometimes an issue regarding follow up care, suture removal and membrane removal, but usually only varied by a few days from the required date. Not all d-PTFE membranes were removed at 4 weeks, some were early and some late. A few cases had sites that were larger than the membranes selected for the study requiring modification or addition of a second membrane. Care had to be taken when enrolling anterior teeth, as reflection of the tissue or overlay grafting may have caused undesired esthetic results.

Case 1:





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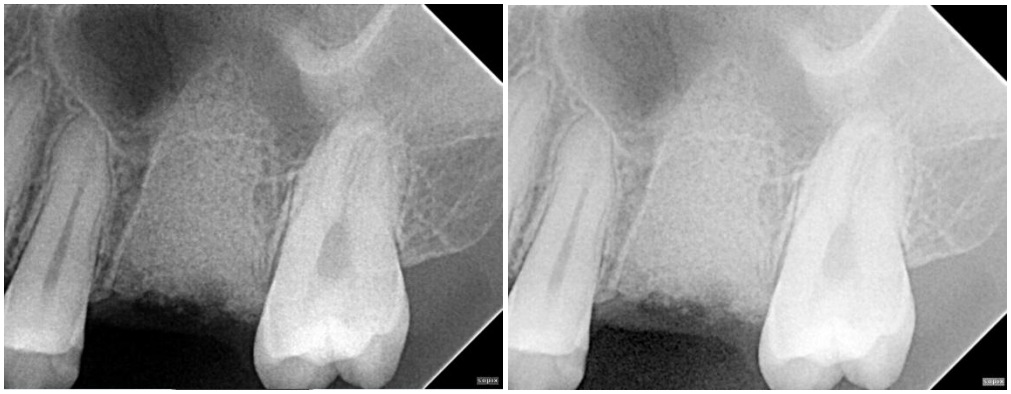

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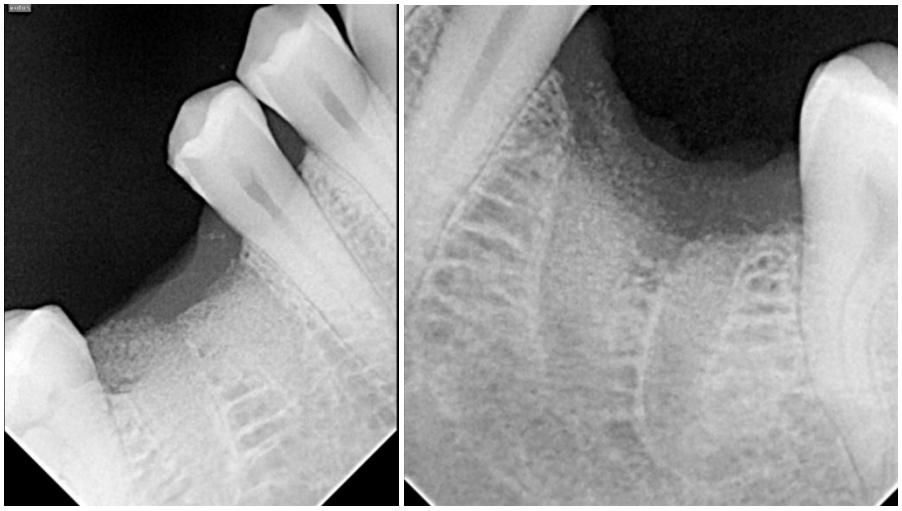

6. Discussion

Even though dentistry has made big steps forward a growing understanding of biological processes, preventing bone loss after pulling out teeth is still a tough problem. People want their new teeth to look just like their natural teeth because of aesthetic demands and cultural norms. While clinicians try to slow down the natural resorption of the alveolar socket after a tooth is removed, but there are still a lot of questions, especially about the materials and methods being used.

One of the major issues is that there isn't enough direct comparison between dental materials. A review of major dental journals showed that less than 2% of articles published over three years compared materials directly. This means dentists often have to rely on evidence that is often biased

since most studies are funded or published by the companies that make the materials being tested. These studies might focus on showing that a material is not inferior rather than proving it's truly better. As a result, dentists need to carefully check how the studies were done, whether there are conflicts of interest, and if there's any bias.

The study found that companies don't have a strong reason to compare their products with others because if the results are bad, it could damage their market position. This means doctors often don't have fair, side-by-side information when looking at new products. This is concerning because relying on information that might be one-sided can affect how clinicians making decision in clinical practice.

This pilot study had some limitations. Although random assignment helped spread patients evenly across the test groups, it didn't consider the position of the teeth. For instance, front teeth (anterior teeth), which often require significant bone augmentation for implants, were not well represented in this study. On the other hand, posterior teeth, which usually have enough bone, sometimes didn't need any augmentation. These differences show that future studies should include a position-specific evaluation.

The study also explored the use of the amnion chorion membrane, a flexible material designed to passively conform to the socket. While the membrane was easy to handle and maneuver, challenges arose when using it in overlay techniques. The material's rapid adherence to wet surfaces complicated placement, particularly when minimal flap reflection was desired.

In summary, the study highlights the importance of unbiased research and comparing materials directly to help make better decisions based on evidence. Addressing these issues would help clinicians make informed decisions and improve results in dental implant treatments, especially when bone augmentation is needed. Future research should focus on well-organized trials that look at specific areas and include feedback from patients. This will give a clearer picture of how well dental materials work and how practical they are.

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