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ORIGINAL STUDY

Evaluation of Xenograft and Hyaluronic Acid Mixture Covered by Amniotic Membrane Versus Same Mixture Covered by Collagen Membrane on Osseointegration of Inserted Implants in Posterior Mandibular Alveolar Ridge

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Abstract

Purpose: The study evaluated the use of xenograft and hyaluronic acid (HyA) mixture covered by amniotic membrane (AM) versus covered by collagen membrane on osseointegration of simultaneous implant inserted in the mandible in the expanded posterior alveolar ridge. **Patients and methods:** Twelve patients were divided equally and randomly into two groups. Group (A) was treated with xenograft and HyA covered by AM after ridge expansion and implants insertion, while, in group (B) collagen membrane (CM) was used as a coverage membrane. Implant stability was recorded at the base time, 3, and 6 months after placement of implant. While, marginal bone loss and bone mineral density was measured at the base time, 3, and 6 months postoperatively. **Results:** There was a significant higher ISQ values at third and 6 months postoperatively in group (A). Regarding marginal bone loss, the variance is not analytically significant between the intended groups. Regarding bone density group (A) showed a significantly increase at the third and 6 months postoperatively. **Conclusion:** Application of xenograft and HyA with AM was proved to improve and accelerate bone healing and osseointegration procedure for dental implants in term of increased bone density, quantity, and improved bone quality and implant stability.

Keywords: Amniotic membrane, Collagen membrane, Hyaluronic acid, Implant stability, Ridge expansion, Xenograft

1. Introduction

The success of dental implant placement predominantly depends on the presence of adequate bone quantity and quality in the edentulous site [1]. Onlay graft, guided bone regeneration, and distraction osteogenesis were used to modify the ridge to have an accepted width and length for implant insertion. However, there are several disadvantages, including increased postoperative morbidity, graft resorption during healing which accounts for up to 25% of volume loss, dehiscence of incision at the donor site, and prolonged grafting maturation which delays implant insertion [2]. Therefore alveolar ridge splitting and expansion was a simple, less-invasive, and a viable alternative technique that expanded the ridge by controlled expansion and condensation that improved quality of bone by condensation of soft bone with simultaneous implant placement [3].

Guided tissue regeneration, using bone graft barrier membranes, was a well-documented procedure designed to correct deficient implant sites [4]. Among natural biomaterials, xenografts are biocompatible, osteoconductive, and plenty of donor sources can be found as bone replacement grafts due to the availability of grafts in unlimited amount and less morbidity in comparison with autogenous bone.

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Also they were promising due to similarities in bone architecture and collagen composition [5].

Hyaluronic acid (HyA) hastened the formation of new bone by facilitating the differentiation of mesenchymal cells when combined with xenograft for regeneration of alveolar defects [6,7].

Amniotic membranes (AM), which were derived from amniotic sacs had been developed to overcome limitations of common membranes. They become available for applications throughout the body. Also, they are biological membranes, which means that they are bio-absorbable and compatible with tissues [8]. They had anti-inflammatory and antibacterial properties, being inert for the immune system, and facilitated cell migration through a protein-enriched matrix [9,10].

Despite the wide uses of AM, few studies evaluate the use of AM as coverage in alveolar ridge splitting in the posterior mandible. Therefore, this prospective study was enrolled to answer the following questions: 1) Does the use of AM have an impact on osseointegration of dental implants? 2) To what extent will AM affect the mechanical and biological stability of dental implants? So, this prospective study aimed to assess the use of xenograft and HyA mixture covered by AM versus collagen membrane (CM) on osseointegration of implant placement in an expanded mandible at the posterior region.

2. Patients and methods

2.1. Study design and sample

The study was a prospective comparable and was implemented to address the objective of using AM versus CM. Total 12 patients were included in the study and two equal groups were used. Group (A) was managed by xenograft and HyA mixture covered by AM after ridge expansion and implants insertion, while, in group (B), the mixture was covered by CM. All procedures were explained to all patients before undergoing operation and informed consent was obtained from all patients. The research ethics committee (REC), of the Faculty of Dental Medicine for Girls at Al-Azhar University has approved the study with Code: REC-SU-23-02.

2.2. Sample size estimation and statistical power

The calculation was estimated using CDC Epi info program version 7.2.0.1 (Atlanta, USA), assuming a power of 80%, with alpha (α) level of 0.05 (5%), a beta (β) level of 0.20 (20%), the total sample size (n) was found to be a total of 12 cases i.e. 6 cases per group is needed based on estimated mean to detect the significant difference between the two groups. 20% of the sample size will be increased to compensate dropping that may occur in the patients.

All patients have been treated according to the group they were assigned to using the same materials, same technique within the same group and same operator for all groups.

2.3. Inclusion criteria were

(1) Missing mandibular posterior teeth, (2) Adequate height of the mandibular alveolar ridge, and (3) Maximum bone width was 4 mm.

2.4. The exclusion criteria were

(1) Systemic diseases that interfere with implant osseointegration, (2) Abnormal occlusal relationship, (3) Bisphosphonate use, and (4) Presence of uncontrolled or untreated periodontal diseases.

2.5. Data collection

All patients were asked to provide cone beam computed tomography to measure ridge width and height. Bone Mineral density (BMD) was recorded by using a virtual implant of a similar type and the diameter was selected from the implant table of software and inserted at the suggested position of implants preoperatively.

Stability of implant: Osstell Mentor resonance frequency analysis (Osstell Mentor; Integration Diagnostics AB, Savedalen, Sweden) was used to measure stability of implant through proposed interval. ISQ value was recorded immediately, 3, and 6 months after placement of implant. Loss of marginal bone: MBL average was determined by deducting height of marginal bone instantly after placement of implant and MBH at 3 and 6 months. Density of bone mineral: BMD average was measured at 3 and 6 months after placement of implant.

2.6. Surgical procedures

Some surgical procedures were performed using local anesthesia, and some with general anesthesia depending on the patient's needs. Local anesthesia was administered as follows; Inferior alveolar nerve block and field block techniques were used to anesthetize surgical field. A full-thickness crestal incision was performed deep into the mandibular alveolar bone. An osteotomy was performed at the desired implant position, and a thin splitting disk of 6.66 mm diameter was then used to cut a horizontal osteotomy line along the narrow alveolar crest, with

saline irrigation. After that wider disk 9.51 mm was used to deepen the osteotomy line. Bone expansion was then started using a sequence of bone expansion drills of increasing width. Then implant site preparation was completed using final twist drills. After that, mechanical implant stability was measured. In group (A), gaps around implants and between buccal and lingual cortices were filled with a mixture of xenograft and HyA and then covered by AM (Fig. 1), while in group (B) mixture was covered by CM.

3. Results

The analytical methods showed no analytical significant variance in ISQ at the base time of surgery between the two studied groups where (*P* value was equal to 0.124) while numerical significant difference was presented at 3 and 6 months postoperatively where *P* values equal to 0.006 and 0.000, respectively (Table 1).

MBL: the variance is not analytically significant between the intended groups over follow-up period (*P* value = 0.110 at 3 months and *P* value = 0.108 at 6 months) (Table 2). This means that MBL around the implant in the AM group was lesser than that obtained in the CM group but without significance.

BMD: numerical methods showed no a statistically significant variance in BMD immediately as surgery between studied groups where *P* value was equal to 0.130. It showed a high significance of BMD in the AM group at 3 and 6 months rather than the CM group, where *P* values were equal to 0.002 and 0.001, respectively (Table 3). These results had indicated that bone density and bone remodeling during the early osseointegration period had been increased and promoted when using AM coverage compared with CM.

Table 1. Average values of ISQ at various time points in A and B groups.

Comparison between AM and CM (ISQ)			Significance
Time point	Group A (AM)	Group B (CM)	*P* value
Base time	66.25	65.25	0.124*
3 month	65.00	62.58	0.006**
6 month	69.75	66.58	0.000***

**P* value is not significant.
***P* value is significant.
****High analytical significance is: [*P* < 0.01].

Table 2. Mean marginal bone loss and significance of difference between group A and B.

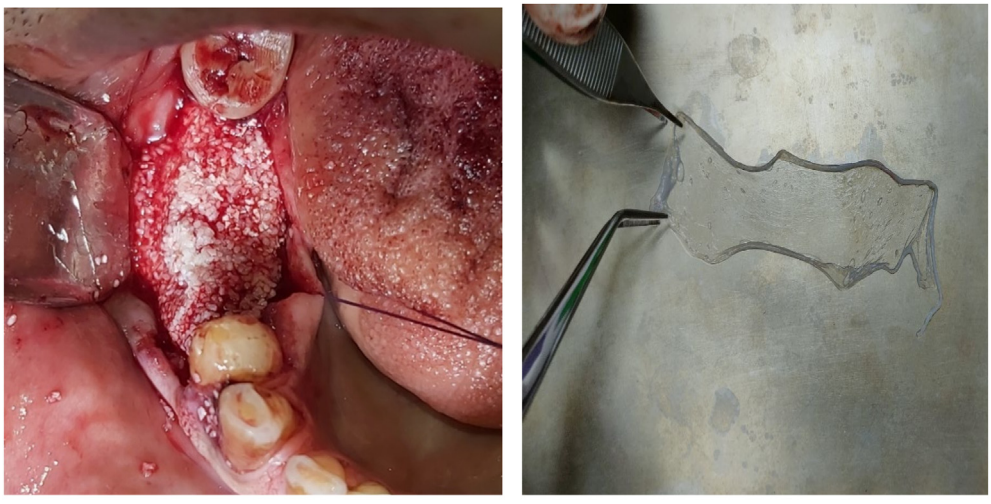
Comparison between AM and CM (MBL)			Significance
Time point	Group A (AM)	Group B (CM)	*P* value
3 month	0.39 ± 0.36 mm	0.50 ± 0.266 mm	0.110*
6 month	0.57 ± 0.36 mm	0.70 ± 0.27 mm	0.108*

**P* value is not significant.

Table 3. Mean bone mineral density and significance of the difference between group A and B.

Comparison between AM and CM(BMD)			Significance
Time point	Group A (AM)	Group B (CM)	*P* value
Base time	700.50 ± 31.10	686.58 ± 30.11	0.130*
3 month	658.67 ± 26.01	629.50 ± 15.33	0.002**
6 month	708.33 ± 16.28	710.17 ± 34.50	0.001**

**P* value is not significant.
***P* value is significant.



(a) (b)

Fig. 1. A photograph showing (a) Packing of bone graft mixture in split alveolar ridge and around dental implants (b) Amniotic membrane prepared for group A.

4. Discussion

Establishing and maintaining implants' stability are prerequisites for successful osseointegration. Therefore, the measurement of implants' stability all over different intervals was well documented in this study, where implants were inserted in the atrophic posterior mandibular ridge after expansion and augmentation with a mixture of xenograft and HyA then covered by AM and CM. Osstell Mentor which is based on magnetic radio frequency analysis was used to measure mechanical and biological implant stability. It was chosen because it was a standard, rapid, non-invasive, and reliable method [11,12].

HyA was used in combination with xenograft as; it had osteoconductive potential that could be valuable in promoting bone healing by proliferation and differentiation of mesenchyme cells and increased osseointegration around dental implant [13].

This study revealed stability of the implant with group (A) and group (B) was gradually increased where ISQ values belonging to medium implant stability ranged between (60 and 69). This result was consistent with Shiigai in 2007 [14] and Anitha et al. at 2014 [15] who had cleared proper stability of the implant with ISQ values of more than 62. At third postoperative month, the mean ISQ values were decreased in both groups. This decrease was reflected the change that occurred during the early healing period. This process could reflect the transition from the primary mechanical stability to the secondary biological stability as a result of osteoclastic activity which results from inflammatory response of the tissues to the surgical trauma.

After 6 months fellow-up, the final ISQ values were presenting higher significant implant stability, of the AM group rather than the CM group. Which was in agreement with the result of Samandari et al. [16] who had got the same results at this point in time. Also, this was confirmed by Anker et al. [17] who had reported that AM was capable of rapid wound improvement and bone induction, due to its high content of mesenchymal stem cells, which provide a suitable substrate for bone induction.

Regarding the results of the MBL, that had showed a higher percentage of bone loss at group (B) than group (A), without statistically significant difference.

Regarding BMD, there was higher significant BMD, of the AM group at 3 and 6 months rather than the CM group. AM was known to provide a basal membrane that enhanced migration of cell, differentiation, and adhesion while reducing inflammation. It was also an ideal substrate for supporting the growth of epithelial progenitor cells by prolonging their lifespan [18]. This was similar to results of Azuara- Blanco et al. [19], where they had found that AM had enhanced a better bone density and neo-osteogenesis.

4.1. Conclusion

Application of xenograft and HyA with AM coverage was proved to improve and accelerate bone healing and osseointegration procedure for dental implants in terms of increased density of bone, quantity of bone, and improved quality of bone, and stability of implant.

4.2. Recommendations

Wide researches will be helpful to estimate the reliability and predictability of AM also to estimate the MBL for a longer interval of observational and larger-scale clinical trials to consider this approach.

Ethical statement

The Research Ethics Committee, Faculty of Dental Medicine for Girls, Al-Azhar University approved our study under code: (REC-SU-23-02).

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Conflict of interest

There are no conflicts of interest.

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