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Influence of a collagen membrane versus a collagen plug in quality of bone regeneration in extraction sockets

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KEYWORDS Socket augmentation, regeneration, xenografts, collagen membrane, collagen plug.

ABSTRACT

Background Collagen barriers play an important role in protection of grafted sites, however quality of bone regeneration depends upon the bone graft material and type of collagen barrier used.
Aim To evaluate the difference between bone quality in extraction socket protected by collagen membrane and collagen plugs.
Setting and design Four study groups were created each comprising of 10 sockets; group 1 with 10 sockets grafted with Bio-Oss bone graft (Geistlich Pharma AG, Wolhusen, Switzerland) and preserved with collagen membrane, in group 2, 10 sockets were grafted with Bio-Oss bone graft and preserved with collagen plug, in group 3, 10 sockets were grafted with Ti-oss bone graft (Ti-oss, Gyeonggido, South Korea) and preserved with a collagen membrane and in group 4, 10 sockets were grafted with Ti-oss bone graft and preserved with collagen plug. The collagen plugs used were Rapi plug, (Dalim Pharma, Seoul, South Korea) and the membranes used were Ossix plus collagen membrane (Datum Dental, Israel)
Materials and Methods Trephine biopsies were taken of the sites and submitted for histopathological examination after being fixed in neutral buffered formalin for 24 hours. Four-micron thick sections were obtained and stained using routine Hematoxylin and eosin stain. The slides were observed with a research microscope (Olympus BX 53).
Result Histological results demonstrated mature bone in all the specimens taken from the 4 groups.
Conclusion A membrane protected site has better quality of bone regeneration especially with a long-lasting barrier membrane such as Ossix plus, nonetheless, it all depends upon the resorption rate of the collagen barrier used.

INTRODUCTION

The need to enhance and mimic natural dentition is the final scale of optimal success that needs to be considered when planning dental treatment. Biophysiological changes which are taking place in the extraction sites needs to be proportioned and rationalized to optimize the requirements of bone grafts in selected cases. Bone graft selection is now considered as one of the mainstays of successful implant treatment. In recent years, with advancements in technology especially in the field of material sciences, newer concepts of grafting and its biochemical properties required vis a vis its biocompatibility has created a sea of change in how we render treatment. Alveolar bone undergoes bone remodeling in a series of events which takes place at the post extraction site (1,2). Immediate placement of bone grafts or immediate implant placement at the extraction site is known to avert bone resorption. However, to preserve the quality of natural human bone, selection of the appropriate type of bone graft material is paramount for long term results.
Callan et al. (3) enumerated several advantages of xenografts over allografts such as biocompatibility and structural similarities to human bone. Also, the variation in osteogenesis due to different donors does not exist as seen in allografts. Several studies (4-7) have also show that xenografts possess excellent osteoconductive properties for the same purpose. Two xenografts of bovine origin were used for this study, Bio-Oss (Geistlich Pharma AG, Wolhusen, Switzerland) and Ti-oss (Ti-oss, Gyeonggido, Korea) as both these materials have demonstrated excellent biocompatibility and good clinical results without any complications (8).

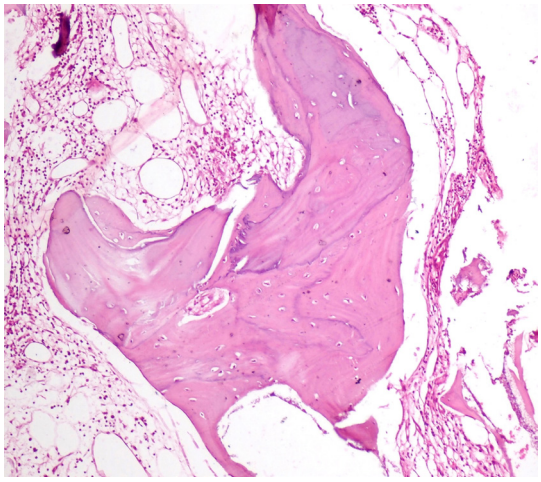

FIG. 1 Histopathological section showing bone healing in group 1 (Bio-Oss bone graft with a collagen membrane).

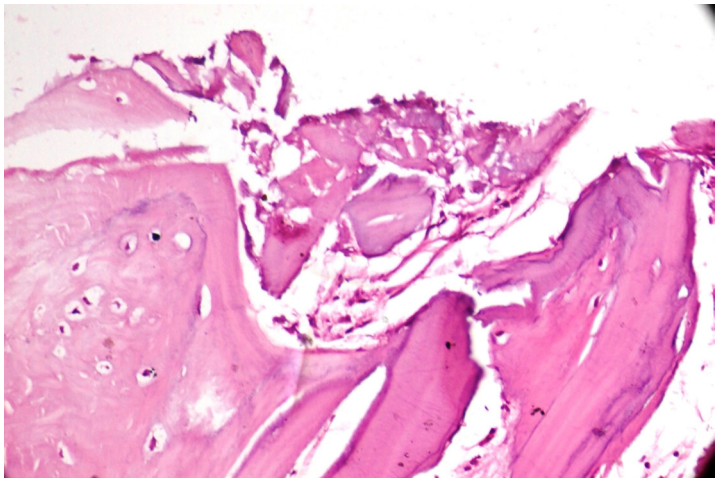

FIG. 2 Histopathological section showing bone healing in group 2 (Bio-Oss bone graft with a collagen plug).

Commonly used regeneration membranes are composed of collagen. Collagen being the most abundant protein in living tissue can be easily purified to be utilized for various purposes such as membranes and plugs that can be used for regeneration and other medicinal purposes (9). Both membranes and plugs are being used for bone augmentation procedures commonly known as guided bone regeneration (GBR) and guided tissue regeneration (GTR) and for both the techniques to be successful, the type of barrier membrane used plays an important role (10). A histological study was conducted by taking core samples removed by trephination of the Ti-oss and Bio-Oss bone graft augmented sockets preserved by either collagen membranes or collagen plugs.

MATERIALS AND METHODS

Forty healthy patients who underwent socket preservation were chosen for the study. Informed written consent was taken from each subject. Four study groups were created each comprised of 10 sockets; in group 1, 10 sockets were grafted with Bio-Oss bone graft and preserved with a collagen membrane, in group 2, 10 sockets were grafted with Bio-Oss bone graft and preserved with a collagen plug, in group 3, 10 sockets were grafted with Ti-oss bone graft and preserved with a collagen membrane and in group 4, 10 sockets were grafted with Ti-oss bone graft and preserved with a collagen plug.

The trephine biopsies were collected following complete site healing and submitted for histopathological examination after being fixed in neutral buffered formalin for 24 hours. After washing in saline, the specimens were decalcified in 5% formic acid and processed using routine tissue processing protocols. The specimens were then embedded in paraffin. Four micron thick sections were obtained, placed on slides and stained using routine Hematoxylin and eosin stain. The slides were observed in research microscope (Olympus BX 53) and photomicroghraphs were clicked using Olympius EPL 3 camera.

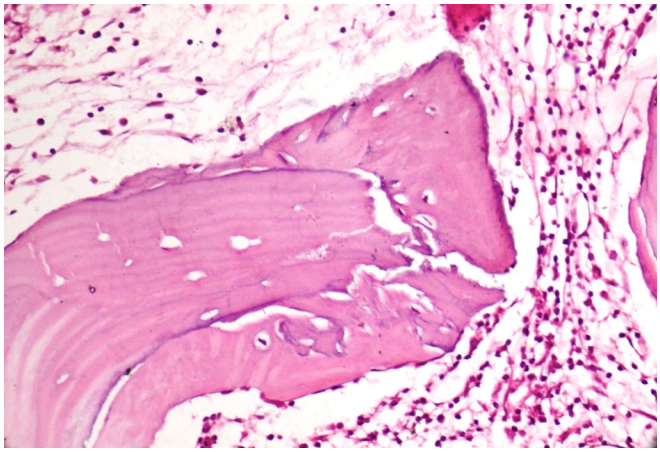

FIG. 3 Histopathological section showing bone healing in group 3 (Ti-oss bone graft with a collage membrane).

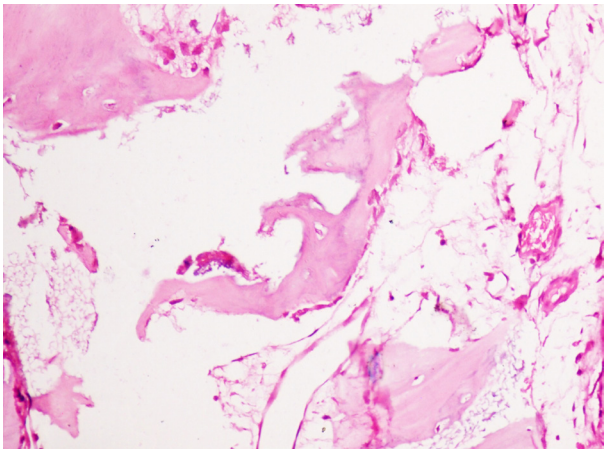

FIG. 4 Histopathological section showing bone healing in group 4 (Ti-oss bone graft with a collage plug).

RESULTS

GROUP 1: Bio-Oss bone graft with a collagen membrane: The decalcified bone specimen demonstrated predominant areas of mature lamellated bone with prominent cement lines indicative of an active remodeling process. The trephine cores were composed of abundant vital bone with minimal graft material present indicative of replacement of the graft material by mature vital bone. This indicates that the majority of the graft material is replaced by mature vital bone (Figure 1).

GROUP 2: Bio-Oss bone graft with a collagen plug: The decalcified trephine core stained with heamatoxylin, and eosin stain showed mature bone with osteocytes entrapped within large osteocytic lacunae. Numerous, large, entrapped osteocytes indicative of rapid new bone formation was noted within the bony trabeculae. Areas of new bone deposition were observed on the periphery with foci of the remnants of the graft material. The graft material leads to directional bone formation indicating guided bone growth at the site where graft particles were noted (Figure 2).

GROUP 3: Ti-oss bone graft with a collage membrane: The heamatoxylin and eosin-stained decalcified section demonstrated mature vital bone with lamellations and prominent resting lines. The bony trabeculae observed to be forming around the graft material particles which acts as a scaffold for guided bone formation. The trabeculae were lined by active plump osteoblasts and associated with osteocytes with lacunar spaces. Areas of newly formed bone appears to be integrating with the old mature bony trabeculae (Figure 3).

GROUP 4: Ti-oss bone graft with a collage plug: The heamatoxylin and eosin stained decalcified section demonstrated areas of active bone formation rimmed by plump osteoblasts at the borders and osteocytes within the osteocytic lacunae in a vascularised stroma. Multiple foci of new bone formation were noted in the section with a scaffold provided by the graft material. Areas of active bone deposition were observed with few remnants of graft material present in the stroma (Figure 4).

DISCUSSION

There are various types of bone grafts available and autogenous bone is considered the gold standard, however it has some disadvantages. Those include; morbidity, donor site harvesting, a longer healing period and patient refusal for a second surgery site to acquire the donor tissue. This has led to scientific advancements and development of other categories of osseous graft materials such as xenografts, allografts and alloplasts. Unfortunately, none of the bone grafts available can match the advantages of autogenous bone, however, they are in many ways similar to natural bone and bovine xenograft is one such bone graft material (11,12). The biggest advantage to bovine graft material is its osteogenic potential is not donor dependent (13). Another advantage being that despite its low absorption rate it has shown enhanced osteoblastic activity.

A collagen membrane or a plug enhances regeneration as it prevents migration of epithelial cells in to the graft material during the initial healing phase while acting as a scaffold for bone deposition in guided bone regeneration (GBR), while promoting platelet aggregation, stabilizing the clot, and attracting fibroblasts thus, facilitating wound healing (14,15) Collagen is a nonresorbable protein, however while its preparation for medicinal use its structured into a resorbable form, therefore depending upon case selection different membrane may be used based upon their resorption rate. Usually, membranes resorb anywhere between (4-32) weeks, but some may stay for a longer period of time (16,17). It should be noted that effective barrier time and resorption time for various membranes is different, the former being always less as compared to the latter (18). Thus, any membrane choosen should be able to maintain its structural integrity during the early maturation of the newly formed tissue which is 4–6 weeks for GTR and 6 months for GBR to support new bone formation and maturation (19). Hence, an optimal functional stability of membranes in vivo should lie in the range from four weeks to several months, which most of the membranes fail to obtain (20). The Ossix Plus membrane (Datum Dental Ltd., Lod, Israel) is one of the very few membranes which resorb between 4-6 months and provide enough time to allow soft and hard tissues maturation (20). When it comes to plugs, they have a dual purpose, apart from acting as a barrier it also helps in clot stabilization and platelet aggregation (21). Plugs are highly absorbent creating an artificial clot-like structure, thereby stopping bleeding at the site while stabilizing graft and will completely resorb within 14 to 56 days (22). There is vast literature showing beneficial results when a membrane is used for guided bone regeneration procedures, whether it is for implant placement, socket augmentation or augmentation of intrabony defects (23). Studies reported by Simon et al. (24) and Jovanovic et al. (25) have demonstrated that vertical augmentation upto 4 mm was possible without the use of any graft material under the membrane. Several authors such as Schenk et al. (26) Park et al. (27), Cordaro et al. (28) and Sanz-Sánchez (29) support the use of membrane for better regenerative results. Some limitations are mainly exposure of the membrane or handling difficulties which may occur with the use of a barrier membranes jeopardizing the regenerative outcomes. But those factors mainly depend upon clinical skills and clinical gain in augmentation with the help of membranes should be considered and given more importance over limitations of membrane use.

Histological findings as aforementioned, did not demonstrate any significant difference when the Ti-oss membrane and plug were compared. However, when a Bio-Oss bone graft with membrane and plug was compared, the former demonstrated better bone formation as compared

with the latter. Yet there was no significant difference, so the authors can not recommend one over the other regarding choice of material.

CONCLUSION:

A membrane protected site has a better chance of bone and graft protection, nonetheless, it all depends upon the resorption rate of the collagen barrier utilized. As aforementioned, studies report a plug resorbs within 14-56 days, whereas a membrane anywhere between 4-32 weeks. Thus choosing a membrane over a plug seems to a be a better option, and a long lasting barrier membrane such as Ossix plus appears to be a good choice of collagen membrane in such clinical situations.

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