

Evolution of Barrier Membrane in Periodontal regeneration

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ABSTRACT

In the last decade guided tissue regeneration (GTR) has been used for the treatment of various periodontal defects like furcation defects, recession defect, intrabony defect, different types of membrane are used to cover a wide range of defects, some membranes not only act as barrier but they can also be used as delivery devices to release various agents like antibiotics and growth factor. In this article we take a brief look at the evolution of barrier membranes and their future avenues.

Keywords: Barrier membrane, Guided tissue regeneration, Collagen membrane, Growth factors

INTRODUCTION

Periodontitis is a globally prevalent inflammatory condition leading to progressive destruction of periodontal tissues and being a major cause of tooth loss. Periodontal regeneration is defined as reconstruction of lost or injured tissues to restore the normal form and function. There is a broad range of treatment option available such as barrier membrane, xenograft, autograft, allografts and various combinations. In 1976 Melcher came up with a concept and suggested that under physiological conditions cells from periodontal ligament can synthesize and secrete cementum to attach newly synthesized collagen fibres of periodontal ligament (1). The term "Guided Tissue Regeneration" was given by Gottlow in 1986. Guided Tissue Regeneration (GTR) employs a barrier membrane around periodontal defect to prevent epithelial migration. Barriers are employed in the hope of excluding epithelium and gingival corium from root surface in the belief that they interfere with regeneration. The rationale behind using GTR membranes is to maintain space between the defect and tooth.

Criterion essential for Barrier Membranes

The various essential criteria include(2):-

1. Be biocompatible and allow tissue regeneration
2. Be non-toxic and non-carcinogenic
3. Be chemically inert and non-antigenic
4. Be easily sterilizable
5. Be easy to store should have long shelf life
6. Should not be too expensive

Classification of Barrier Membrane

First Generation Membrane

First generation membranes are non-resorbable membrane, developed in 60s and 70s aimed to achieve a suitable combination of physical properties to match with those of replaced tissue eliciting minimal toxic response in the host. In the first bacterial filter produced from cellulose acetate (Millipore) was used as an occlusive membrane by Nyman et al, in 1982(4). Although this membrane served its purpose but it was not very ideal for clinical application. Later various other membranes were utilized like expanded polytetrafluoroethylene (e-PTFE), Gore-Tex (5) specially designed for periodontal regeneration, some other non-resorbable membranes are Titanium reinforced ePTFE, high density-PTFE or titanium mesh(6), titanium reinforcement have found to produce superior regenerative capacity as compared to traditional ePTFE membranes. The major drawback of first generation membranes is the need for second surgery for removal of these membrane due to their non-resorbable nature.

Second Generations Membranes

Second generation membranes are resorbable membranes, thus avoiding the need for surgical removal. These membranes can be further of two types:- Natural and Synthetic. Natural membranes are made of collagen or chitosan, successful treatment following the use of these materials have been done but the results of studies vary(7). Various complications like early degradation, epithelial downgrowth were reported following their use. Synthetic membranes are made of polyesters ex-polyglycolic acid, polylactic acid, polycaprolactone, these materials are biocompatible but they are not inert therefore some tissue reactions can be expected during their degradation. There is also lack of control over the resorption rate of membrane which is influenced by various factors like local pH, composition of material (8).

Third Generation Membranes

Third generation membrane are resorbable membrane with growth factors, as the concept of tissue engineering has developed these third generation membranes have evolved they not only act as barrier but they also act as delivery devices and release specific agents such as antibiotic, growth factors, adhesion factor etc, on the site of wound as and when required and do direct

wound healing in a much better way. They may be considered into following subdivision- i) Barrier membrane with antimicrobial activity

Bacterial contamination of the regenerating wound is the most significant factor that leads to compromised outcome. The bacteria found on GTR membrane include various gram positive as well as periodontal pathogen, membrane bacterial count is positively associated with gingival recession and negatively with clinical attachment gain(9). Systemic antibiotics are usually prescribed after GTR operation to prevent infection however the results are not predictable. It was demonstrated that incorporating the various antibiotics like amoxicillin, tetracycline into various GTR membranes enhance the periodontal attachment despite the presence of various oral pathogens(10).

ii) Barrier Membrane with bioactive calcium phosphate incorporation

Various studies on membrane prepared by Liao et al., showed that the addition of nano carbonated hydroxyapatite (nCHAC) improved both biocompatibility and osteoconductivity of the membrane.

iii) Barrier Membrane with Growth Factor release

Growth factor has an essential role in the healing process, they influence tissue repair and various processes like angiogenesis, chemotaxis, cell proliferation. Various bioactive molecules have demonstrated strong effects in promoting periodontal wound repair. These bioactive molecules include PDGF, IGF1, Fibroblast growth factor (FGF-2), TGF-1, BMP-2, 4, 7, 12 and enamel matrix derivative and all have shown positive results in periodontal regeneration(11).

RECENT DEVELOPMENTS IN GTR MEMBRANES

i) Electrospinning (e-spinning) for membrane

The e-spinning technique has showed great potential for processing membranes for periodontal regeneration. Recently it has been used to produce various scaffolds for tissue regeneration. Electrospinning produces a biocompatible and degradable natural or synthetic polymers that resemble the arrangement of native extracellular matrix. Li et al demonstrated the ability of nanofibre structure to support cell attachment and proliferation(12). Systematic reviews on e-spinning process and applications of these nanofibers in tissue engineering are available(13,14).

ii) Functionally Graded Multilayered membranes

Use of multi-layered barrier membranes was proposed to enhance bone growth while preventing the gingival tissue downgrowth. With this in mind fabrication of functionally graded three-layered membrane from PLGA, collagen and nano hydroxyapatite by a layer by layer casting method. A novel functionally graded membrane (FGM) was designed and fabricated with a multilayering-spinning(15).

iii) Platelet-Rich Fibrin membrane - An Autologous membrane

PRF was first developed in France by Choukroun et al. for specific use in oral and maxillofacial surgery(16). The protocol of PRF is simple: A blood sample is taken without anticoagulant in 10 ml tubes which are immediately centrifuged at 3000rpm for 10 mins. Fibrin clot is obtained in the middle of the tube, Platelets are theoretically trapped massively in fibrin meshes. By driving out the fluid trapped in the fibrin matrix very autologous fibrin membranes are obtained. Gassling et al claimed superior results when PRF membrane was used as a scaffold for human periosteal cell proliferation compared to collagen(17).

CONCLUSION

GTR procedure has been, and still is widely employed in periodontal practice and has been established as a basic technique in periodontal regenerative medicine. Although the indications of GTR membrane in periodontal regeneration are limited to three wall and class II furcation defects, researchers are putting more efforts to include more advanced periodontal defects with a predictable outcome. Combinations of several techniques such as GTR in association with bone grafts may offer more chances for a beneficial outcome although substantial evidence is still lacking. "IDEAL" membrane for use in periodontal regenerative therapy has yet to be developed.

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