Barrier membranes for GBR: characteristics and indication

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Introduction: The use of physical barriers to isolate cells with regenerating interest and prevent the penetration of cells inappropriate to the repair has been demonstrated over the past few decades. The use of membranes on bone reconstructions has important benefits. The barrier membranes can be non-absorbable or absorbable, which have collagen of bovine and swine as the most used material in its structure. **Objective:** The objective of this work is to present through a literature review the main features of the membranes used in guided bone regeneration (GBR), their indications, advantages, disadvantages and clinical applications. **Discussion:** the size of the reconstruction is also a factor that can influence the relative time of resorption and need for barrier, also the use of double-layer membrane can favor the barrier action, and maybe change the pattern of reabsorption. **Conclusions:** Literature demonstrates that the presence of membrane preserves the grafted volume, especially when positioned in double layer. More research regarding the recommended barrier time and degradation of absorbable membranes are still necessary.
Keywords: Alveoloplasty. Bone transplantation. Guided tissue regeneration.

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INTRODUCTION

In the last decades the beneficial effects and favorable results from the use of membrane for Guided Tissue Regeneration (GTR) as physical barriers have been attested, in order to isolate regenerative cells and to block migration of improper cells into the healing area. They allow the cells of periodontal ligament and those from bone medulla to migrate to dental root surface, leading to the regeneration of periodontal insertion. Guided Bone Regeneration (GBR) emerged from the results obtained by GTR.

Early attempts of demonstrative GTR technique was made by Nyman et al. (1982) using Milipore filter (cellulose acetate) as a barrier for the treatment of a deep infra-bone pocket in mandibular incisor. Two types of membranes are indicated for both GTR and GBR: resorbable and non-resorbable. Ideally they should be safe, biocompatible, non-toxic, non-antigenic, and induce little or no inflammation. Nowadays, a number of membranes are available for the clinicians, and the choice of the material must consider basic characteristics as biocompatibility, cell blockage, tissue integration, formation and maintenance of the space, easy handling, and induce little complication.

REVIEW OF THE LITERATURE

It is evident that the use of the membranes makes GTR therapy possible. The advantage of using resorbable membranes is that a second surgical procedure is avoided.

Primary and secondary objectives for GTR may be listed as follows:

Primary:

- Successfully bone regeneration of the defect with high predictability allowing long-lasting function and aesthetic;
- Low complication risk;

Secondary:

- Less surgical procedures;
- Low morbidity for the patient;
- Reduced healing period.

Repair process is recognized by the formation of granulation tissue for the reconstruction of the connective tissues. It occurs in bone, cartilage, and fibrous connective tissues.[7] When it comes to bone grafts, this concept is accepted, since there is the formation of granulation tissue. In the present study, the term Guided Bone Regeneration will be used, considering previous published manuscripts that used this nomenclature, although the term Guided Bone Repair could be correctly used. Authors have described regeneration as the replacement of the removed or lost components in the organism by similar tissue, resulting in a complete recovery of the structure and function of the organ. Physiological regeneration is different from healing regeneration that occurs due to injury or disease.[8]

Obviously, the choice of the material is very important when it comes to GTR/GBR resorbable membranes. A number of resorbable and non-resorbable materials were evaluated in animal models and recent clinical experiences. Depending on the material, inflammatory reaction has been reported in the tissues close to the resorbable membrane.[9] Non-resorbable barrier membranes require a second surgical procedure in order to remove it. This disadvantage let to the development of biodegradable membranes. Various biodegradable materials have been successfully tested in periodontal and/or bone regeneration, including Type I collagen, polyurethane, polyglactin 910, polyglycolic acid, polyorthoester, as well as different copolymers of polylactic and polyglactin acid.[10,11,12]

The capacity of collagen to promote cell adhesion, quimiotaxis, homeostasis, along with its physiological degradation, easy handling, and low immunogenicity, turns it into an ideal material to be used as resorbable membrane,[13,14,15,16] both from bovine and porcine origins.[13,17,18]

When the resorbable membranes are placed in a hydrated environment, as the biological system, its biodegradable polymers undergo four degrading stages: hydration, loss of strength, loss of mass and integrity, and digestion by phagocytosis. Duration of each stage and global degradation rate depend on the origin of the polymer, pH, temperature, crystallization, and membrane volume.[9,19]

It is suggested that degradation rate and function of the barrier is not fully controlled, and that resorption process can eventually interfere in bone healing. However, although resorbable membranes have eliminated the necessity of a surgery for their removal, facilitating the protocol and improving the relation cost-efficency, it has been suggested that PTFE-e (expanded polytetrafluorethylene) membranes must be considered as the golden pattern for comparative studies of new materials.[9]

The necessary period for the persistence of the membrane separating bone and connective tissues vary from 3 to 12 months, depending on the size of the bone defect.[15,20,21] In this way, it is interesting the membrane used in GTR/GBR resists resorption for a long period, in order to act as a barrier during GTR/GBR process.

Complication factors to be considered: (1) the presence of different specialized cells in healing process; (2) the complexity of tissue insertion; (3) cell and environment interaction; (4) variety of oral microbiota; and (5) avascular dental surfaces.

Table 1: Resorbable and non-resorbable membranes characteristics

RESORBABLE	NON-RESORBABLE
Bovine and porcine origin collagen; Bovine bone; Polylactic and polyglactic acid;	Bovine and porcine origin collagen; Bovine bone; Polylactic and polyglactic acid;
Low morbidity Simple technique and single surgical procedure	Low morbidity Simple technique and single surgical procedure
Low risk of complications	Low risk of complications

Table 2: Characteristics of the most used commercially available resorbable membranes in Brazil, according to fabrication information.

MEMBRANE	MANUFACTURER	MATERIAL	RESORPTION
	Geistlich	Porcine collagen	4 to 6 months
Osseoguard®	Biomet 3i	Bovine collagen	6 to 7 months
Genderm®	Genius/Baumer	Collagen derived from bovine bone	45 days
Genderm flex®	Genius/Baumer	Colágeno derivado de osso bovino	60 days
*CollaTape®	Zimmer	Bovine collagen	14 days
*CollaCote®	Zimmer	Bovine collagen	14 days
BioMend®	Zimmer	Bovine collagen	8 weeks
BioMendextend®	Zimmer	Bovine collagen	18 weeks
CopiOs®	Zimmer	Bovine pericardium	24 weeks
Socket Repair®	Zimmer	Bovine collagen	26/38 weeks
Lumina-Coat®	Critéria	Bovine collagen	4 a 6 weeks
Lumina-Coat Double-Time®	Critéria	Bovine collagen	8 a 10 weeks

*Hemostatic curative – inserted in the Table due to its routine application in GTR, although it is not indicated

The most common complication is the membrane exposure to oral cavity. It favors bacterial adherence and proliferation, and it is an entry rout for pathogens into the healthy periodontal tissue. PTFE-e are colonized around three minutes after its exposure to oral cavity.[22,23]

In this way, it is observed that different materials have been used for GTR therapy as barriers in order to isolate the cells that produce undesirable tissues, and to avoid their proliferation into the healing area.

DISCUSSION

Membranes used as barriers in bone reconstruction is indicated in a number of clinical situations as: block homogenous and autogenous bone grafts, particulate grafts in bone fenestrations associated to dental implants, and ridge preservation.

CollaTape and CollaCote membranes are recommended for hemostasis, and not as barriers, being clinically indicated for bleeding and accidental rupture of Schneiderian membrane in sinus lift procedures. During guided bone regeneration, the necessary cells are mature in wound site around 2-3 weeks, and the time membrane maintains integrity must be enough to permit the selective entry of cells. A longer period is recommended for guided bone regeneration. However, it is considered the duration of membrane integrity is a key factor for the formation and maturing of the new bone tissue in the defects protected by the membrane.[24] Besides these recommendations, the ideal period for the membrane to maintain its function as barrier is still to be determined. It would be desirable that the membrane stays in the position at lease the formation of new bone; however, the longer it stays, lower bone loss will occur.

The size of the reconstruction is also a factor that can influence resorption rate and the necessity of the barrier.

Authors recommend the use of a double layer membrane, favoring its barrier action and probably changing its resorption pattern. KIM ET AL, 2009,[25] studying Bio-Gide membrane in rabbit calvarias observed three experimental groups: block bone grafts without membrane, associated with a monolayer membrane, and with a double layer membrane. After 2, 4, and 6 months resorption rate of both membranes and grafts were analyzed by histological and morphometric analysis. Results showed that collagen membrane can reduce graft resorption. In addition, double layer membrane can improve the technique and reduce graft resorption when compared to monolayer membrane.

FINAL CONSIDERATIONS

Membranes used as barrier for bone grafts act and directly influence in the maintenance of graft volume, and it can be recommended for block and particulate grafts from different origins.

Integrity period is important and must be considered when choosing a membrane, as well as its biocompatibility, causing a minimum of inflammation.

Resorbable membrane should be in the position as long as possible, especially in large reconstructions.

Further researches are needed in order to recommend the barrier time needed, and resorption rate.

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