PHYSICO-CHEMICAL PROPERTIES OF BARRIER MEMBRANES

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Abstract

Introduction: Guided Bone Regeneration (GBR) techniques are nowadays essential procedures in implant dentistry where barrier membranes are crucial to avoid soft tissue ingrowth. Not all membranes behave in the same way, as they differ in origin and structure. It is therefore important to understand membranes behavior and properties in order to select the needed biomaterial for each possible situation. To date no study has evaluated and compared physico-chemical properties of various families of barrier membranes. The aim of this study was to evaluate the physico-chemical properties of various barrier membranes.

Materials and Methods: 5 different origin membranes were tested for this study. Porcine Peritoneum (BioGide, (Geistlich Pharma AG, Wolhusen, Switzerland)), Bovine Cross-linked Collagen (Cytoplast RTX, (Osteogenics Biomedical, Lubbock, TX, USA), Porcine Cross-linked Collagen (Ossix Plus, (Datum Dental, Israel)), Bovine Collagen + Hyaluronic Acid (Imploflex, (Bioimplon GmbH, Gießen)) and Polycaprolactone (Osteoguide, (Genoss, Korea)). All membranes were tested in terms of tension, stiffness, absorption ability, pH and wettability. All data were translated into radial graphics showing the differences and strongest and lowest potential for each membrane. A physico-chemical index was then calculated.

Results: All membranes showed similar low tension and little stiffness. Porcine origin membranes had greater wettability and hydration, whereas bovine origin barrier membranes had a lower hydration and wettability, especially if mixed with hyaluronic acid. Synthetic membranes had a very stable pH and were very little stiff, which can be of importance in some GBR techniques.

Conclusions: The wide variety of barrier membranes opens a debate in which the practitioner should select the ideal barrier membrane for each clinical situation. Different materials show singular potentials depending on their tissue origin. More studies regarding adsorption, integration and degradation of barrier membranes are needed in order to understand their behavior.

Results

Microstructure variance among membranes depending on they tissue origin.

1. Porcine Peritoneum
2. Bovine Cross-linked Collagen
3. Porcine Cross-linked Collagen
4. Bovine Collagen + HA
5. PCL

Different tension patterns depending on the tissue origin. Significant differences between dried membranes and all other groups.

All membranes except PCL had a significant increase in weight over hydration. Porcine origin membranes had the greatest absorption. All membranes were in a physiological pH range, between 7,3 and 7,4.

Most membranes had a low contact angle after 30 seconds when compared to 4 seconds. Wettability was higher for porcine origin barrier membranes, followed by the bovine cross-linked barrier membranes that showed no differences after 30s. Bovine tendon collagen + HA and PCL barrier membranes exhibited similar wettability, the sessile drop could be appreciated even after 30s.

Radial graphs summarizing the physicochemical properties of the studied barrier membranes are exposed. Cross-linked barrier membranes presented a greater overall physicochemical index compared to other membranes, especially to alloplastic. Depending on the clinical situation a more stiff or flexible membrane would be preferred. With the actual available information, clinicians might have a physicochemical barrier membrane guide to choose the appropriate material for each regenerative procedure.

Background and Aim

The main function of barrier membranes is to separately guide the bone/tissue regeneration avoiding the ingrowth of epithelium and connective tissue in the bone compartment. Barrier membranes should fulfil 5 main properties: biocompatibility, space maintenance, occlusivity, easy handling and bioactivation friendliness. Regarding the mechanical properties, it has been established that a balance must be set between the mechanical stability and stiffness to ensure a proper regeneration. Besides the mechanical stability of a membrane, it is important to understand how a membrane will behave in contact with biological fluids.

The objective is to compare different commercially available barrier membranes and analyse their mechanical and physicochemical properties in order to have a database of the general functional properties of the membranes. The intention is to broaden the knowledge in the regeneration field and clarify their clinical use.

Conclusion

The understanding of the physical and chemical properties of barrier membranes is essential for an optimal result. All membranes experienced a decrease in the mechanical properties once they were introduced into an aqueous solution. Different samples of the biomaterials presented similar pH values after the absorption test, in which porcine derived barrier membranes experienced an increased absorption capacity reaching a plateau in most cases after 4min. Increased wettability values were obtained for rough surfaces. Different mechanical properties of barrier may affect the clinical characteristics of a biomaterial. More studies are needed for a further comprehension of the bone regeneration science.

Methods and Materials

- Porcine Peritoneum Collagen
- Bovine Cross-linked Collagen
- Porcine Cross-linked Collagen
- Bovine Tendon Collagen + HA
- Polycaprolactone (PCL)

References

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