17e Journées Scientifiques
GFP-Section Est / FRMNGE
06 et 07 juillet 2021

Bone regeneration in rat calvaria defect boosted through a hybrid functionalized collagen membrane

Marie Dubus[1], Loïc Scomazzon[1], Hassan Rammal[1], Adrien Baldit[2], Julien Braux[1], Cédric Mauprivez[1], Halima Kerdjoudj[1]

[1] Université de Reims Champagne Ardenne, EA 4691 Biomatériaux et Inflammation en Site Osseux (BIOS), Reims, France.
[2] LEM3-UMR-7239, CNRS - Arts et Métiers ParisTech; ENIM, Université de Lorraine, Metz, France.

Résumé

Guided bone regeneration (GBR) is an attractive technique for restoring oral bone defects, where an occlusive membrane provides space maintenance required to seclude soft tissue infiltration. However, bone regeneration can be impeded by a lack of an adequate tissue vascularization and/or by bacterial contamination. A bone inspired coating made of calcium phosphate-chitosan-hyaluronic acid was built on one side of a GBR collagen membrane.

The resulting hybrid coating is composed of amorphous calcium phosphate and carbonated poorly crystalline hydroxyapatite, wrapped within chitosan/hyaluronic acid complex. Hybrid coated membrane possesses excellent bioactivity and capability of inducing an overwhelmingly positive response of stromal cells and monocytes in favor of bone regeneration [1,2,3,4]. Furthermore, the hybrid coating disturbs the cell wall integrity of Gram-positive and Gram-negative bacteria. Its combination with stromal cells, able to release antibacterial agents and mediators of the innate immune response, constitutes an excellent strategy for fighting bacteria [5].

A preclinical *in vivo* study was therefore conducted in rat calvaria bone defect. µCT reconstructions showed that hybrid coated membrane favored bone regeneration, as we observed a two-fold increase in bone volume / total volume ratios *vs.* uncoated membrane. The histological characterizations revealed the presence of mineralized collagen (Masson's Trichrome and Von Kossa stain), and immunohistochemistry analysis highlighted a bone vascularization at 8 weeks post-implantation. However, second harmonic generation analysis showed that the newly formed collagen was not fully organized. Despite a significant increase in the elastic modulus of the newly formed bone with hybrid coated membrane (*vs*. uncoated membrane), the obtained values were lower than those for native bone (approximately 3 times less).

This bioinspired hybrid coating provides a suitable environment for bone regeneration and vascularization, as well as an ideal strategy to prevent bone implant-associated infections.

Références

1. Rammal H., Dubus M., Aubert L., Reffuveille F., Laurent- Maquin D., Terryn C., Schaaf P., Alem H., Francius G., Quilès F., Gangloff S. C., Boulmedais F., Kerdjoudj H. ACS Appl. Mater. Interface, 2017
2. Rammal, H., Bour, C., Dubus, M., Entz, L., Aubert, L., Gangloff, S. C., Bercu N. B., Audonnet, S., Mauprivez, C., Kerdjoudj, H. Int. J. Mol. Sci, 2018
3. Dubus, M.; Rammal, H.; Alem, H.; Bercu, N. B.; Royaud, I.; Quilès, F.; Boulmedais, F.; Gangloff, S. G.; Mauprivez, C.; Kerdjoudj, H. Colloids Surf. B Biointerfaces, 2019.
4. Rammal, H., Entz, L., Dubus, M., Moniot, A., Bercu, N., Sergheraert, J., Gangloff, S., Mauprivez, C., Kerdjoudj, H. Frontiers in Bioengineering and Biotechnology, 2019.
5. Dubus, M., Varin-Simon, J., Prada, P., Scomazzon, L., Reffuveille, F., Alem, H., Boulmedais, F., Mauprivez, C., Rammal, H., Kerdjoudj, H. Biomaterials science, 2020.