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Fusion peptide P15-CSP coatings suppress biofilm formation and advance mesenchymal stem cell osteogenic differentiationon hydrophilic but not hydrophobic surfaces

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In periodontal bone reconstruction procedures, bone growth is enhanced byosteogenic factors and impaired by wound infection. PepGen P-15 (P15) is an osteogenic collagen-mimetic peptide, and competence stimulating peptide (CSP) is a cationic amphiphilic peptide with antimicrobial activity. This study analyzed whether surfaces coated with P15-CSP fusion peptide have dual anti-infective and pro-osteogenic activities *in vitro*. Plastic surfaces were dry-coated with or without P15-CSP, CSP, P15, or left uncoated, then inoculated with *Streptococcus mutans or* seeded with human mesenchymal stem cells (MSCs). CSP coatings inhibited *S. mutans* planktonic growth while P15-CSP coatings suppressed biofilm formation. P15 had no antimicrobial or anti-biofilm activity. MSCs adhered and spread more rapidly on P15-CSP and CSP coatings compared to P15-coated and uncoated culture wells, although CSP-coatings showed slight cytotoxicity to MSCs after 24 hours of culture. After 3 weeks in osteogenic culture, MSCs up-regulated alkaline phosphatase activity on tissue culture plastic and P15, CSP and P15-CSP coatings, with a selectively higher matrix mineralization on P15-CSP-coated surfaces ($p<0.05$). In other assays, peptides were adsorbed to surfaces pre-coated with thin films of plasma-polymerized hydrophilic carboxylated ethylene (L-PPE:O) or hydrophobic hexamethyl disiloxane HMDSO. MSCs expressed alkaline phosphatase activity on carboxylated surfaces with higher matrix calcification when L-PPE:O was further coated with P15 or P15-CSP. Unexpectedly, MSCs cultured on hydrophobic thin films developed alkaline phosphatase activity and failed to calcify, with or without peptide coatings. This study revealed that P15-CSP coatings stabilized by electrostatic interactions exert dual properties of anti-biofilm activity, and accelerated MSC adhesion and end-stage osteogenic differentiation.

Biography

Hoemann (Ph.D., MIT, 1992) is a full professor of Chemical Engineering and Biomedical Engineering at the Ecole Polytechnique in Montreal, Canada, and an FRSQ National Research fellow. She has published over 50 articles, 3 opinion papers and 6 patents in the area of tissue engineering, cartilage/bone repair, and blood/innate immune responses to biomaterials. She is a member of the Orthopedic Research Society, Fellow Member of the International Cartilage Repair Society, lead author on the ICRS recommendation paper, "International Cartilage Repair Society (ICRS) recommended guidelines for histological endpoints for cartilage repair studies in animal models and clinical trials, Cartilage 2011, 2:153-172" and serves on the editorial board of Cartilage, and The Open Orthopaedics Journal. She spent 5 years as Director of Cartilage Repair, in a Montreal-based biomedical device company, where she co-invented and co-developed a novel medical device for articular cartilage repair, BST-CarGel® that was tested in an 80-patient randomized controlled clinical trial, received CE-mark approval, and is now being used in European clinics. Her current research program has created novel bioengineered biomaterial blood clot implants, developed new methods for staining and analyzing human cartilage repair biopsies, and has made advances in understanding the role of therapeutic inflammation and subchondral bone remodeling in cartilage repair responses. Her translational research program aims to understand the influence of local inflammation on cartilage and bone repair, in order to bring new treatment options to patients with arthritis.

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