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Developing Scaffolds with Antimicrobial Properties for Tissue Regeneration Using Low Temperature Plasma (LTP)

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Statement of Problem: Cardiovascular diseases are a major concern affecting a lot of people worldwide. The treatment often involves bypass surgery, using the autologous vein which, however, can run into the issue of vein stenosis. Therefore, there is a need to develop an alternate viable vascular graft with antimicrobial properties for sustainability in the human body. The present study aims to improve the endothelialization of intimal surface of graft by using low temperature plasma (LTP) for the cell attachment and proliferation along with implying antimicrobial properties.

Methodology: Medical grade PTFE was treated with LTP using an air plasma jet (APJ) system. The scaffolds were also modified with gelatin and collagen. Likewise, the scaffolds were modified with Ag-PVP and the antimicrobial peptides (AMPs p753, p359 Owen Biosciences) to impart antimicrobial properties.

Human umbilical vein endothelial cells (HUVEC) were plated on the developed scaffolds and cell proliferation was determined by the MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide assay using established protocols. Cells attachment on scaffolds was visualized by microscopy after staining. mRNA expressions levels of different cell markers were investigated using quantitative real-time PCR (qPCR).

Antimicrobial studies with E.Coli were conducted using MIC and plate counts both in 2D and 3D using human cells.

Findings: XPS confirmed the introduction of oxygenated functionalities from LTP. HUVEC cells showed 80% seeding efficiency on the scaffold. Microscopic and MTT assays indicated an increase in cell viability in LTP treated scaffolds especially when treated with gelatin or collagen compared to untreated scaffolds. Gene expression studies show enhanced expression of cell adhesion marker Integrin- α 5 gene after LTP treatment. Minimum inhibitory concentration (MIC) values with E.Coli were 100 µg/mL and 12.5 µg/mL respectively for Ag-PVP and AMPs. LTP treated scaffolds exhibited better cell proliferation and viability compared to untreated scaffolds. Protein treatment of scaffold increased cell proliferation.

Conclusion & Significance: LTP treated, and protein functionalized scaffolds exhibited better cell proliferation and viability compared to untreated scaffolds. Employed antimicrobial agents appear to be effective in E.Coli inhibition and did not cause any biocidal activity against human cells in 3D using PTFE. Based on our initial results, more scaffolds alternatives will be developed and investigated for cell growth and vascularization studies.

Biography

Vig`s has expertise in nanobiotechnology, microbiology, biotechnology, tissue engineering, plasma medicine etc. She is focused on designing nanomaterials as antimicrobials, delivery agents and as therapeutics. She is also working with low temperature plasma to modify scaffold surfaces for designing grafts for tissue engineering. She is currently running federal grants in these areas. Besides, she is involved in student training grants which support both undergraduate and graduate students.

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