The Role of Bacterial Cellulose in Advancing Regenerative Medicine Through Enhanced Healing, Infection Management, and Tissue Engineering

Reddy, Pranav (School: St. Andrew's Episcopal School)

Bacterial cellulose (BC) is a promising biomaterial for wound healing and regenerative medicine due to its biocompatibility, water retention, and high tensile strength. This study evaluates BC's potential in infection management and promoting fibroblast proliferation for use as an advanced wound dressing/scaffold in tissue engineering. To evaluate BC's antibacterial properties, hydrogels were treated with the minimum inhibitory concentration of amoxicillin (2 μg/mL) of Escherichia coli and tested on Mueller-Hinton agar plates containing E. coli. Eighteen plates were incubated at 37°C for 24 hours, treated, and then incubated for another 24 hours, with bacterial colonies and diameters measured at each time point. After the initial 24-hour incubation, six plates were treated with antimicrobial-infused BC, six with BC alone as controls, and six with no BC as negative controls. Results showed a significant reduction in bacterial growth ($p < 0.0001$) in antimicrobial-treated BC samples compared to untreated controls and negative controls, confirming BC's ability to inhibit bacterial proliferation. To assess cell proliferation, mouse embryonic fibroblasts (MEFs) were cultured in 96-well plates, with BC added after 24 hours to allow cell adherence to wells. MTT assays performed after 48 hours showed a significant increase in fibroblast viability in BC-treated wells ($p < 0.01$), suggesting BC's potential as a scaffold/hydrogel for cell attachment and growth. These findings demonstrate BC's ability to prevent infection and promote tissue regeneration. BC's tissue repair capabilities can be paired with growth factors or stem cells to enhance its regenerative potential, opening new possibilities for its use in tissue engineering, organ scaffolding, and advanced biointegration.

Awards Won: