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Development of 3D Printed, Conductive, Biodegradable Nerve Conduits for Neural Regeneration

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Abstract : Damage to nerves is considered one of the most irreversible injuries. The regeneration of nerves has always been an important topic in regenerative medicine. In general, damage to human tissue will naturally repair overtime. However, when the nerves are damaged, healed flesh wound cannot guarantee full restoration to its original function, as truncated nerves are often irreversible. Therefore, the development of treatment methods to successfully guide and accelerate the regeneration of nerves has been highly sought after. In order to induce nerve tissue growth, nerve conduits are commonly used to help reconnect broken nerve bundles to provide protection to the location of the fracture while guiding the growth of the nerve bundles. To prevent the protected tissue from becoming necrotic and to ensure the growth rate, the conduits used are often modified with microstructures or blended with neuron growth factors that may facilitate nerve regeneration. Electrical stimulation is another attempted treatment for medical rehabilitation. With appropriate range of voltages and stimulation frequencies, it has been demonstrated to promote cell proliferation and migration. Biodegradability are critical for medical devices like nerve conduits, while conductive polymers pose great potential toward the differentiation and growth of nerve cells. In this work, biodegradability and conductivity were combined into a novel biodegradable, photocurable, conductive polymer composite materials by embedding conductive nanoparticles in poly(glycerol sebacate) acrylate (PGSA) and 3D-printed into nerve conduits. Rat pheochromocytoma cells and rat neuronal Schwann cells were chosen for the in vitro tests of the conduits and had demonstrate selective growth upon culture in the conductive conduits with built-in microchannels and electrical stimulation.

Keywords : biodegradable polymer, 3d printing, neural regeneration, electrical stimulation
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