Neural degeneration resulted from various traumas and diseases, represents a preponderance of health problem all over the world. Although various cell therapies and implants have been investigated, repairing damaged nerves and achieving full functional recovery are still challenging. For instance, autografts are usually difficult to collect sufficient donor nerves from patients in addition to possible impairment of donor site nerve function. Given the limited self-regeneration of neural system and defective clinical therapeutics at present, the development of novel strategies to improve and guide neural regeneration is desirable. Tissue engineering technique combined biomaterial and cell provides an attractive option in improving therapeutic effect in comparison with traditional clinical approaches. In this study, we developed a novel tissue engineered scaffold which possesses highly aligned poly caprolactone (PCL) microfibrous framework and bovine serum albumin (BSA) embedded poly (D, L-lactide-co-glycolide) (PLGA) nanospheres fabricated by electospinning and electrospraying techniques. The aligned microfibers play a role in guiding axon propagation to the ultimate injured targets. Meanwhile, the introduction of BSA loaded PLGA nanospheres can alter the PCL scaffold’s surface properties (such as increased nano surface roughness and wettability) and promote neural cell adhesion and proliferation. More importantly, neurotropic factors could be easily loaded inside the PLGA nanospheres and be sustainably released to enhance neural tissue regeneration in a long term.

I. MATERIALS AND METHODS

PCL was dissolved in chloroform to form 12% (w/v) clear solution for electospinning. PLGA was dissolved in acetone in a concentration of 2.5% solution for electrospraying nanospheres. Aligned PCL microfibrous scaffolds were fabricated via our electospinning facility. Core-shell PLGA nanospheres with 1 mg/ml BSA aqueous solution inside were produced by co-axial electrospraying process and sprayed onto PCL microfibrous scaffolds. As control, equivalent bare BSA was directly sprayed onto PCL scaffolds in the absence of PLGA nanospheres. Studies on cell-scaffold interaction were carried out by culturing rat pheochromocytoma (PC-12) cells on PCL scaffolds, PCL with BSA embedded PLGA nanospheres and PCL with bare BSA for 2, 4 and 6 days. The cell proliferation was quantified via a CellTiter 96® AQueous Non-Radioactive Cell Proliferation Assay (MTS assay). Scanning electron microscope (SEM) was used to image scaffold morphology.

II. RESULTS AND DISCUSSION

SEM results (Fig. 1) of electrospun PCL fibrous scaffolds show highly aligned and interconnected porous architecture under controlled conditions. Sprayed PLGA nanospheres improved surface roughness of scaffolds (Fig 1b). Contact angle was decreased from 148° ± 4 of PCL to 127 ° ± 4 of PCL with PLGA nanospheres, which demonstrated that the presence of PLGA nanospheres on the scaffolds resulted in better hydrophilicity. This may be attributed to the introduction of hydrophilic hydroxyl groups of PLGA. More importantly, our MTS results revealed a significant increase (p<0.05) for neural PC-12 cell proliferation on PCL scaffolds with BSA embedded PLGA nanospheres compared to PCL and bare BSA directly sprayed PCL scaffolds after 4 and 6 days.

III. CONCLUSIONS

Our studies demonstrate the potential of a novel highly aligned PCL scaffolds with BSA embedded PLGA nanospheres for nerve tissue engineering. These scaffolds can promote neural cell proliferation and guide their growth while maintaining a sustained release of neurotropic factors.

Figure 1. SEM images of electrospun fibers: (a) aligned PCL (b) PLGA nanospheres coated PCL

Figure 2. PC12 cell proliferation after culturing 2, 4 and 6 days. Data are ±SEM, n=3; *p<0.05 when compared to PCL with bare BSA and PCL on day 4 and 6