Structure and Porosity Control of Electrospun Poly(lactic-*co*-glycolic acid) (10:90) Nanofiber Webs according to Conditions of Electrospinning

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1. INTRODUCTION

One-dimensional (1D) nanostructures have been a subject of intensive research due to their unique properties and intriguing application in many areas. A large number of synthetic and fabrication methods has already been demonstrated as generative 1D nanostructure in the form of fibers, wires, rods, belts, tubes, spirals, and rings from various materials. Among these methods, electrospinning seems to provide the simplest approach to nanofibers with solid and hollow interiors that are exceptionally long in length, uniform in diameter, and diversified in composition. Biomedical field is one of the important application areas among those utilizing the electrospinning like filtration and protective material, electrical and optical applications, sensors, nanofiber reinforced composites, etc.

Among the biodegradable polymers, poly(L-lactic acid) (PLA), poly(glycolic acid) (PGA) and their copolymers have been extending their applications to surgical sutures, implant materials, drug carriers, and scaffolds for tissue engineering, because they have a diverse biodegradability, good mechanical properties, and biocompatibility.

In this study, electrospinning of poly (lactic-co-glycolic acid) (PLGA) (10 : 90) in 1,1,1,3,3,3-hexafluoro-2-propanol (HFIP) was investigated to fabricate a biodegradable micro/nano structured matrix for tissue engineering. The structure of PLGA nanofiber webs was characterized by SEM, image analyzer and porosimeter. The cytotoxicity and biocompatibility of the nanofiber webs were also measured by WST-1 and microscopes.

2. EXPERIMENTAL

2.1. Electrospinning of PLGA

PLGA solutions in various concentrations were prepared by dissolving PLGA polymer in HFIP. Electrospinning of the solution was carried out using a needle with an inner diameter of 0.495mm and a high voltage supplier of 20keV. Randomly oriented fiber assembly was collected at a rate of 4 ml/hr over a grounded plate which was located at a distance of 15cm from the needle tip. The thickness of the electrospun PLGA nanofiber webs was around 150 ㎛.

2.2. Cell seeding

Electrospun PGLA nanofiber webs were washed in 70% ethanol and dried in clean bench. After drying, the webs were washed by Phosphate Buffered Saline (pH 7.4) three times, and the webs were neutralized with distilled water. NIH 3T3 fibroblast cells from mouse embryo tissue were seeded and cultured on PLGA nanofiber webs with the seeding density of $1x10^4$ cells/cm^2.

2.3. Characterizations

The structure and porosity of the electrospun PLGA nanofiber webs were observed SEM, image analyzer and porosimeter. The cytotoxicity and biocompatibility of the nanofiber webs were measured by WST-1 and fluorescent microscopes.

3. RESULT and DISCUSSION

HFIP was used as a solvent for electrospinning, for PLGA (10:90) was not dissolved in solvents commonly used in the electrospinning of PLGA such as DMF, THF, and ethyl alcohol. Figure 1 shows the PLGA nanofiber webs obtained by electrospinning.

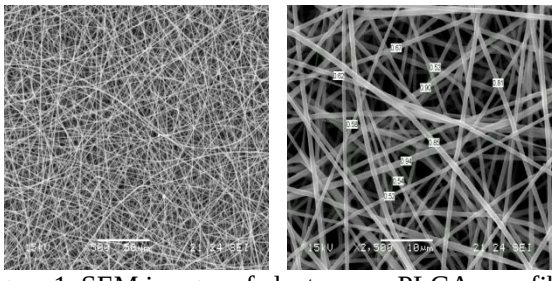

Figure 1. SEM images of electrospun PLGA nanofiber webs obtained with 10wt% of PLGA in HFIP

When HFIP solutions with 3~7wt% of PLGA were used, many polymer bulbs and beads were formed and the uniformity of diameter was poor. However, uniform PLGA nanofibers with mean

diameters of 650~750nm were obtained with 10wt% of PLGA in HFIP. In this study, among the various concentrations of spinning solution, the most uniform and finest PLGA nanofiber webs were obtained with 10wt% of PLGA in HFIP solution. After electrospinning, the PLGA nanofiber webs were annealed at 60°C for morphologic stability.

The pore size distribution of PLGA nanofiber webs was shown in Figure 2.

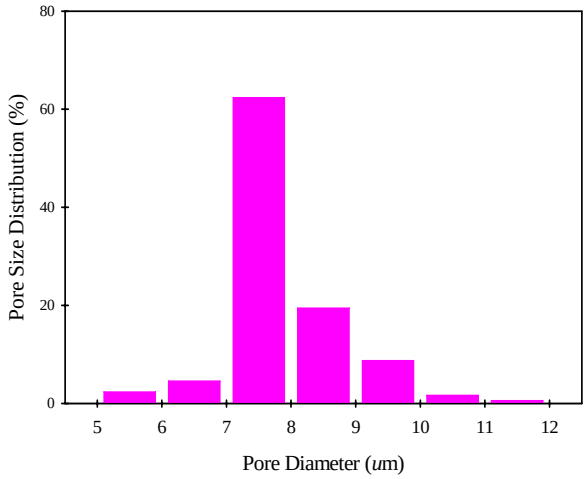

Figure 2. The pore size distribution of electrospun PLGA nanofiber webs (spinning rate : 4ml/hr)

The average pore size was 6~10㎛ and 60% of the pore size was 7~8㎛ when spinning rate was 4 ml/hr. As a result of preliminary experimental, the mean pore size of PLGA nanofiber webs was 10~11 ㎛ when spinning rate was 8ml/hr. The average pore size was also influenced slightly by the total quantity of spinning solutions. In this study, the pore size of the PLGA nanofiber webs could be controlled by electrospinning conditions.

NIH 3T3 fibroblast cells were seeded and cultured on PLGA nanofiber webs for 3, 5, 6, and 7 days. The cell proliferation was analyzed by SEM and fluorescent microscope. Figure 3 shows SEM images that the cells were attached on the electrospun PLGA webs, covering the pores between fibers after 3days of incubation.

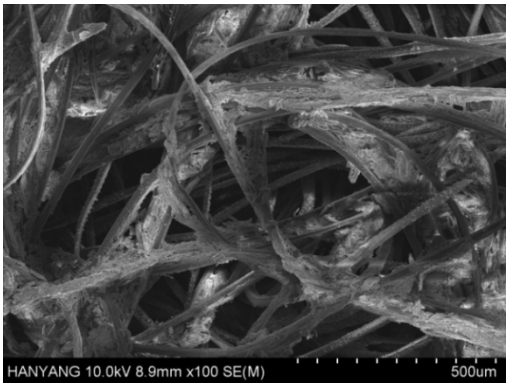

Figure 3. SEM images of cell seeded on electrospun PLGA scaffold after 3days of incubation

4. CONCLUSION

The average fiber diameter (690nm) and pore size (7~12㎛) of PGLA nanofiber webs were obtained by electrospinning a 10 wt% PGLA solution in HFIP. The results of cell seeding on the webs indicated that the well fined nanofiber webs were prepared, and their application on tissue therapy was confirmed.

ACKNOWLEDGEMENT: This study was supported by grants from MKE (Grant no. 10030042).

5. REFERENCES

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