Nanofibers: Potential applications in wound care management

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Abstract

The wound healing is complex process and brings immense challenges to researchers. Human tissues and organs exhibit nanofiber structures. The nanofiber provides an alternative approach for wound healing treatment. Nanofibers are produced by electrospinning technique and showed promising approach in management of wound care applications. These nanofibers exhibited better biodegradability and biocompatibility properties with tissues or organs. The drug or growth factors loaded nanofibers stimulate the tissue regeneration around the wound and wound healing process occurs. Therefore, nanofiber can be served as powerful tools in advanced wound care management. The present review article expressed about achievements of nanofibers in wound care.

Key Words: Nanofibers, Electrospining, Wound healing

INTRODUCTION

Nanofibers are a nanomaterial with one dimension less than 100 nm. Wide range of polymers such as polyvinylalcohol, gelatin, collagen, chitosan and carboxymethylcellulose can be subjected to electrospinning technique to produce nanofibers. Nanofibers have large specific surface area with small pore size and these unique properties showing opportunities in management of wound care applications [1]. The benefits of the nanofibers are; development of nanofiber layers from different polymer, drugs or growth factors can be incorporated into different nanofiber layers for wound care management. Role of nanofibers in advanced wound care managements are; a) absorption of exudates, b) addition of drugs to the nanofibers and showing anti-adhesive effect. In addition, nanofibers can be used in drug delivery systems to improve control drug delivery of drugs via nanofibers [2]. Therefore, nanofibers have potential applications in wound care management. The present review describe about achievements of nanofibers in wound care management.

Production of Nanofibers: Electrospinning Technology

Polymeric nanofibers can be prepared using the electrospinning process. In the electrospinning process, an electric field is applied to draw a polymer stream out of solution. The process engages a polymer solution that passes through a spinneret. To make the extrusion force, a high voltage generates the electric field, such that the particles within the solution become charged, producing a repulsive force. At a specific voltage, the repulsive force conquers the surface tension of the polymer solution and the solution ejects out of the spinneret in a jet stream. The formation of nanofibers occurs when the solvent get evaporates. Finally nanofibers are collected and patterned on a grounded plate. The benefits of electrospinning technology are; a) high rate of nanofiber can be produces; b) simple set up and production costs is low [3].

Application of Nanofibers in Wound Care Management

1. Poly-N-acetyl glucosamine fibers

Treatment of diabetic mice with short fiber poly-N-acetyl glucosamine (sNAG) did not inhibit angiogenesis in clopidogrel-treated mice and produce rapid wound closure. This study suggested that sNAG is a promising approach to facilitate the wounds healing in clopidogrel-treated diabetic mice [4]. Short fiber poly-N-acetyl glucosamine nanofibers (sNAG) are potential hemostatic agents that stimulate wound epithelialization. Combination of Vacuum-assisted closure (VAC) device with sNAG showed wound healing...
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Nanofibers

2. Curcumin-loaded poly (epsilon-caprolactone) nanofibers

Curcumin-loaded poly (epsilon-caprolactone) nanofibers matrix showed anti-oxidant and anti-inflammatory properties in a streptozotocin-induced diabetic mice model and the results suggested that could be used as wound dressing in diabetic mice [8].

3. EGF-conjugated nanofibers

Recombinant human epidermal growth factor (EGF) was immobilized with electrospun block copolymers composed of poly (epsilon-caprolactone) [PCL] and poly (ethyleneglycol) [PEG] nanofibers were subjected to in vivo wound healing activities in diabetic ulcer mice. The results indicated that EGF-nanofibers exhibited considerable in vivo wound healing effects. Epidermal growth factor (EGF)-conjugated nanofiber could be potential candidate for management of wound complications [9].

4. Chitosan-ethylenediaminetetraacetic acid (CS–EDTA)

Chitosan-ethylenediaminetetraacetic acid (CS–EDTA) was subjected to electrospinning process to produce nanofibrous mats with lysozyme. This lysozyme loaded CS–EDTA nanofiber mats were subjected to in vivo wound healing studies in Wistar rats. The results indicated that lysozyme release was observed from the nanofiber mats and improved the wound healing effects [10].

5. Nanofiber membrane

Composite nanofibrous membranes (NFM) composed of collagen and chitosan, known for wound healing effects. This membrane showed wound healing and induces cell migration and proliferation in wound induced-rat model. These results expressed that NFM was more suitable than gauze and commercial collagen sponge in wound healing [11].

CONCLUSION

Conventional wound care is the basic treatment modality for treatment of wounds. However, topical growth factors have been used for the treatment of acute and chronic wounds that fails the wound healing effects alone. Now, new trends have been introduced in the field of nanotechnology. Therefore, nanofibers have been developed for the management of wound care. The nanofiber can be used as tissue adhesion barrier. Nanofibers could be used for both acute wounds (burns, surgical wounds) and chronic wounds (diabetic ulcer). Even though nano-technology is well developed, but still it is far from clinical applications due to the several challenges. However, drugs or growth factors loaded nanofibers showing promising approach for the management of wound care. In the advanced wound care field, nanofibers could be effective to provide adequate scientific data for clinical support.

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REFERENCE


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