LUPINE PUBLISHERS
Open Access

Research and Reviews on Healthcare:
Open Access Journal

DOI: 10.32474/RRHOAJ.2018.02.000127

ISSN: 2637-6679

Review Article

Recent Breakthroughs in Textile Materials for Wound Care

N Gokarneshan*

Department of Textile Technology, Park College of engineering and technology, India

Received: May 15, 2018; **Published:** May 23, 2018

***Corresponding author:** N Gokarneshan, Professor and Head, Department of Textile Technology, Park College of engineering and technology, Coimbatore, Tamil Nadu, India

Abstract

The article surveys some significant trends in the textile wound dressing during recent years. An ideal wound Dressing need to be redefined based on the nature of wound and wound classifications. Since generations, wound have been defined as self-healing process, but chronic wounds and other wound requires handling and care from different parameters like moist conditions, biocompatibility, microbial infection to mention a few. Bioactive dressings based on different materials sodium alginate, chitosan, hydrocolloid, iodine have been explored. The future of fiber technology for medical applications depends largely on the future needs of our civilization. The use of new fibers for healthcare textiles application has increased rapidly over the past quarter of a century. With the recent advances in tissue engineering, drug delivery, and gene delivery- alginate, chitin/chitosan and their derivatives present a novel and useful class of biomaterials. Hence small changes in their molecular structure can bring large changes in their interactions with components of biological tissues or drugs. These polymers are excellent candidates for applications in the biomedical field because of their versatility, biocompatibility, bio absorbability and significant absence of cytotoxicity. Modern wound dressings combine medical textiles with active compounds that stimulate wound healing while protecting against infection. Electrospun wound dressings have been extensively studied and the electrospinning technique recognized as an efficient approach for the production of nanoscale fibrous mats.

Keywords: Electrospun polymeric dressings; Wound healing, Bioactive; Polysaccharides

Introduction

Human body has strong immune system with capabilities of self-healing. The protective layer of the skin protects the body against the external environment. The important layers of skin are Epidermis (outermost layer), Dermis (middle layer) and subcutaneous fat (deepest layer). The Epidermis consists of dead cells of keratin, which makes this layer water proof whereas dermis consist of living cells, blood vessels and nerves running through it, which provides structure and support. The subcutaneous fat layer is responsible for insulation and shock absorbency [1]. In normal skin, there exists an equilibrium between epidermis and dermis [2]. Wound dressing design and fabrication are important segments of the textile medical and pharmaceutical wound care market worldwide. In the past, traditional dressings were used to simply manage the wound, to keep it dry and prevent bacterial entrance. Nowadays, the fabrication of wound dressings aims to create an optimal environment that accelerates wound healing, while promoting oxygen exchange and intensively preventing microbial colonization [3]. The use of natural fibers in medical applications spans to ancient times. These fibers afford a bioactive matrix for design of more biocompatible and intelligent materials owing to their remarkable molecular structure. Oligosaccharides and polysaccharides are biopolymers commonly found in living organisms, and are known to reveal the physiological functions by forming a specific conformation. There has been an intensified effort in recent years in identifying the biological functions of polysaccharides as related to potential biomedical applications.

Wound Dressings of Third Generation

Wound is defined as any cut or break in the layer of skin. The normal process of wound healing starts operating once the

protective barrier is broken. Majority of wounds heal without any complication. because cells on the surface of the skin are constantly replaced by regeneration from below with the top layers sloughing off. However, in case of chronic non- healing wounds, there is more tissue loss and the natural process of healing is disturbed, thus special care is required for rapid and hygienic healing [4]. This thus poses the biggest challenge for wound care product researchers and developers. The purpose or aim of choosing a wound dressing is to protect the wound from infection, ease pain, promote healing and to avoid maceration. Usually, the selection of wound dressing depends on the type of the wound. Traditionally, different materials like neem paste, honey paste, turmeric, animal fats, etc. were used as wound dressing materials. But these traditional or homemade wound healing methods could not control the infection which hampers the healing process. Continuous efforts are in progress to develop wound dressings which can improve the healing process. Nowadays, different materials are in use for rapid and cosmetically acceptable healing. Thus materials are being developed with special emphasis on solving complexities of the healing process, speedy healing and prevention of scarring i.e., keloid formation or contractures.

Wound management and wound care has gained importance in recent years. Global market is flooded with different varieties of wound dressings. Some of the polymeric materials used in wound dressings are based on hydrogel materials, sodium alginate, hydrocolloid, collagen to mention a few. Different wound dressings are selected based on the type of wounds. The major problem of exudate management is a matter of concern. Advances have been made to achieve wound management with better absorption systems using super absorbent polymers and developing layer dressing (composite dressings). The various advances made in wound dressings have been reviewed with special focus on layered dressings with superabsorbent polymers.

Chitosan Dressings

Chitosan is a valuable natural polymer derived from chitin. Chitosan is known in the wound management field for its anti-viral, anti-fungal, non-toxic, non-allergic, biocompatible, biodegradable properties and helps in faster wound healing but it exhibits excellent anti-bacterial activity [5,6]. Chitosan dressings show scar prevention which is the most important criteria in today's world of wound dressing technology [5]. Chitosan wound dressing has excellent oxygen permeability, controlled water loss and water-uptake capability. There are number of references on chitosan in wound treatment [6-11]. Wound dressing and wound management is an active area of research developing biocompatible dressings with more focus on bioactive materials incorporating growth factors. Speciality absorbents are the need for treatment of chronic wounds, highly exudating wounds, and in total cosmetically acceptable healing.

Electrospun Polymeric Dressings for Improved Wound Healing

Electro spinning has become one of the most popular processes to produce medical textiles in the form of wound dressings. This is a simple and effective method to produce nanoscale fibrous mats with controlled pore size and structure, from both natural and synthetic origin polymers. This technique has gain much attention because of its versatility, reproducibility, volume-to-surface ratio and submicron range [12-14] [2-4]. Recently, functionalizing these electrospun wound dressings with active compounds that accelerate wound healing and tissue regeneration has become the major goal [15]. The rising of antibiotic-resistant infection agents has increased the need for such therapies. While antibiotics act selectively against bacteria, dressings functionalized with antimicrobial peptides (AMPs) act at multiple sites within microbial cells, reducing the likelihood of bacteria to develop resistance [16]. The combination of collagen type I (Col I), one of the most important extracellular. matrix (ECM) proteins to wound healing, with these AMP-polymer mat systems has yet to be investigated. Col I has been highlighted as uniquely suited for wound dressing therapies because of its involvement in all phases of wound-healing [17]. Thus the combination of Col I with the AMPs would represent a new step further in the optimization/development of new generation wound dressings.

Due to the continue rising of antimicrobial resistant pathogens, the need for engineered alternated treatments for acute to chronic wound care has increased. As a first strategy to overcome this issue, AMPs have been loaded onto existing textile medical dressings to improve their healing and antimicrobial capacities [18]. We highlighted the most well known AMPs and the most appropriate methods to functionalize the surface of electro spun mats with such molecules. This is still a very new formulation and further research should be conducted. Indeed, long-term therapeutics using AMPs. functionalized dressings should be carefully evaluated to prevent the risk of compromising our innate immune defense and, therefore, the ability to control commensal microbiome and microbial infections. Functionalizing surfaces with AMPs should be managed by standardized tests that not only evaluate the action of the AMPs but as well its stability, releasing abilities and tunable performance. The level of control in peptide loading and release timescales that are required in applications that could benefit from such antimicrobial profile has thus far not been demonstrated. Because they are still being developed and tested, these systems, AMPs-polymeric mat, should be cautiously defined so that the best combination between selected polymer, mechanism of action, AMPs and immobilization process is achieved. Although Col I has been extensively used in wound healing and its potential already demonstrated, the combination with AMPs-polymeric mats systems has yet to be explored. In a near future, we intend to examine the synergistic performance of these molecules in the treatment of

chronic wounds, namely diabetic ulcers. It is expected that these new systems aside from acting against the pathogens will also accelerate the wound healing process by establishing a symbiotic action.

Role of Polysaccharide Fibres In Wound Management

Polysaccharides appear in many different forms in plants. They might be neutral polymers or they might be poly anionic consisting of only one type of monosaccharide, or they might have two or more, up to six different monosaccharide types. They can be linear or branched and they might be substituted with different types of organic groups, such as methyl and acetyl groups. Other types of polysaccharides isolated from plants used in the traditional medicine were identified as having their biologically active sites in the complementary system, the case of arabinans and arabinogalactans [19]. In moist healing concept, alginate fiber becomes one of the most important fibers in the wound dressing [20]. The incorporation of biological agents into the fiber used for nonwoven wound dressings provide a means for directly introducing such agents to the wound without a separate application and with no additional discomfort to the patient. Many authors discussed the wound healing ability of the alginate fiber with different modification [21,22]. The Second part discusses the chitin and chitosan polysaccharides and their applications in various medical fields. The specialty of chitin and chitosan fiber is, its high biocompatibility, non toxic and ability to improve wound healing and therefore it is evaluated in a number of medical applications10 such as drug delivery wound dressing, etc [23-26].

Alginate in Wound Dressings

Physical and chemical properties of alginate dressing depend on the relative content of calcium and sodium ions and the relative concentration and arrangements of the mannuronic and guluronic monomers. Dressing rich in guluronic acid react readily with sodium ions and form stronger gels. On the other hand, mannuronic acid rich dressings form fewer gels. Alginate fibers have a unique ion exchange property [27]. On contact with wound exudates, the calcium ions in the fiber exchange with the sodium ions in the body fluid and as a result, part of the fiber becomes sodium alginate. Since sodium alginate is water soluble, this ion-exchange leads to the swelling of the fiber and the insitu formation of gel on the wound surface. This Now a days there are various types of alginate fibers and dressings available, utilizing the diversified properties of the different types of alginate extracted from different sources of seaweeds and the availability of many types of salts of alginate, such as zinc and silver alginate, which are used for zinc-deficient people and for antimicrobial properties respectively [28]. Due to their unique properties and the fact that the dressings can be used in the dry form or hydrated form, alginate dressings can be used for a wide range of wounds, providing a cost-effective treatment that involves a minimum number of dressing changes.

Chitin and Chitosan in Wound Dressings

Especially using the two polymers in medical applications has attracted interest because of having a lot of advantages as being natural renewable resources, being the most abundant polymeric material in the earth, biocompatibility, biodegradability, easy availability, nontoxicity, the ability to chelate heavy metals, Interestingly, some antibacterial and antifimgal activities have been described with chitosan and modified chitosan derivatives. Due to the antimicrobial property both Chitin and chitosan has long been known as being able to accelerate the wound-healing process. It has been shown that by applying chitin dressings, the wound healing process can be accelerated by up to 75% [29]. Textile materials are very important in all aspects of medicine, surgery and healthcare and extend of applications to which the materials used because of the versatility of textile materials. Advances in fiber sciences have resulted with a new breed of wound dressing, which contributing healing process in an effective way [30]. The role of polysaccharide fibres in wound management has been highlighted. Also the different properties and requirements of various polysaccharide fibers to the healing of different wounds have been discussed. In particular special properties of Alginate, chitin and chitosan were summarized with the various experimental results of different researchers.

Conclusion

Traditional methods have been continuously worked upon to deliver better products. Starting from simple gauze dressings in 1900's to bioactive dressings till today have been worked upon. Bioactive dressings based on different materials sodium alginate, chitosan, hydrocolloid, iodine has been covered in this review. Based on wounds different classifications of type of wounds, correlation of wounds with wound dressing have also been focussed upon. This has led to development of interactive dressings which are further developed as per wound requirement viz. semipermeable and hydrogel dressings. Efforts are in process to develop super absorbing and bioactive material for critical wound care. The conventional primary and secondary dressings have been replaced by composite dressings composed by 4 to 5 layers with super absorbing materials incorporated in one of the layers which accumulates exudates from the wounds and also provides protection from leakage and thus avoiding cross infections which at times become a major concern. This article focuses on changing trends in the area of wound dressings through three decades. Wound healing rate depends mainly on proper dressing materials. Over the last few years there has been a rapidly expanding interest in polysaccharides from both a fundamental viewpoint and also from an applications viewpoint. With different varieties of polysaccharides in modern wound dressings, this article discusses the effective utilization of polysaccharide fibers like alginate, chitin and chitosan for the medical application, specifically for wound management. Further it explains the current research status and also summarizes the

different findings of researchers. The unique diverse function and architecture of antimicrobial peptides (AMPs) has attracted considerable attention as a tool for the design of new anti-infective drugs. Functionalizing electrospun wound dressings with these AMPs is nowadays being researched. These new systems have been explored by highlighting the most important characteristics of electropsun wound dressings, revealing the importance of AMPs to wound healing, and the methods available to functionalize the electrospun mats with these molecules. The combined therapeutic potential of collagen type I and these AMP functionalized dressings will be highlighted as well; the significance of these new strategies for the future of wound healing will be clarified.

References

1. Paul W, Sharma CP (2004) Chitosan and Alginate Wound Dressings: A Short Review. Trends Biomaterial Artificial Organs 18(1): 18-23.
2. Wound healing (2018) Wikipedia the free encyclopaedia.
3. (1998) Severian Dumitriu, Polysaccharide-Structural diversity and functional versatility. Marcel

Dekker Inc.

4. Sharma S, Dua A, Malik A (2014) Third generation materials for wound dressings, International journal of pharmaceutical sciences and research 5(6): 2113-2124.
5. Ong, Shin Y, Wu J, Moochhala M, Tan H, et al. (2008) Development of a chitosan-based wound dressing with improved hemostatic and antimicrobial properties. Biomaterials 29(32): 4323-4332.
6. Mi FL, Wu YB, Shyu SS, Schoung JY, Huang YB, et al. (2002) Control of wound infections using a bilayer chitosan wound dressing with sustainable antibiotic delivery. Journal of Biomedical Materials Research 59(3): 438-449.
7. Yu Z, Shi L, Sun YF, Li P, Zhang ZLA (2012) research of the uses of chitosan dressings. Jiankangyanjiu 32(4): 298-301.
8. Zhou, Qun fei Ao, Ning-jian (2013) Researches and applications progress of chitosan-based wound dressing film. Gaofenzitongbao (8): 68-75.
9. Ju, Lu-Kwang, Dashtbozorg S, Vongpanish N (2013) Wound dressings with enhanced gas permeation and other beneficial properties.
10. Lou CW, Lu CT, Hu JJ, Lin WJ, Lin, et al. (2013) Property evaluation of sodium alginate/chitosan compound dressings. Advanced Materials Research (Durnten-Zurich, Switzerland) 627: 849-854.
11. Yu Zhen, Shi Lu e, Sun Yong fu, Li Ping, Zhang Zhi liang A (2012) research of the uses of chitosan dressings. Jiankangyanjiu 32(4): 298-301.
12. Liang D, Hsiao BS, Chu B (2007) Adv Drug Deliv Rev 59(14): 1392-1412.
13. Hunley MT, Long TE (2008) Polym Int 57(3): 385-389.
14. Lannutti J, Reneker D, Ma T, Tomasko D, Farson D (2007) Electro spinning for Tissue Engineering Scaffolds. Mater Sci Eng C 27: 504-509.
15. Reddy K, Yedery R, Aranha C (2004) Antimicrobial peptides: premises and promises. Int J Antimicrob Agents 24: 536-547.
16. Bahar AA, Ren D (2013) Antimicrobial peptides. Pharm 6(12): 61543-61575.
17. Brett D (2008) A Review of Collagen and Collagen-based Wound Dressings. Wounds 20(12): 347-356.
18. Felgueiras HP, Amorim MTP (2017) Electrospun polymeric dressings functionalized with antimicrobial peptides and collagen type I for enhanced wound healing. IOP Conf Ser, Mater Sci Eng 254: 062004.
19. Severian Dumitriu (1998) Polysaccharide-Structural diversity and functional versatility. Marcel Dekker Inc, USA.
20. S Rajendran, SC Anand (2006) Contribution of Textile to medical and Healthcare products and developing innovative medical devices. Indian Journal of Fiber and Textile Research 31(1): 215-229.
21. S Adanur (1995) Wellington Sears Handbook of Industrial Textiles. Technomic Publishing Company Inc, Pennsylvania, USA.
22. Aly sayad aly, Ali hashem, Samaha Sayed Hussein (2004) Utilisation of Chitosan citrate as crease-resistant and antimicrobial finishing agent for cotton fabric. Indian Journal of Fiber and Textile Research 29(2): 218-222.
23. T Chandy, B Ajithkumar, CP Sharma (2005) J Applied Biomaterial 22: 165.
24. R Langer, NA Peppas (1981) Present and Future application of Biomaterial in controlled drug delivery system. Biomaterials 2(4): 201-214.
25. F Mi, S Shyu, Y Wu, S Lee, J Shyong, et al (2001) Fabrication and characterization of a sponge like asymmetric chitosan membrane as a wound device. Biomaterials 22: 165.
26. E Baardseth (1966) Seaweeds Symposium in Halifax. Pro V Int, Pergamon Press, UK.
27. Y Qin, DK Gilding (1996) Alginate fibers and wound dressing. Medical Device Technology 7(9): 32-41.
28. Y Qin (2004) Textile Asia 25-27.
29. Minami, Y Okamoto, Si Tanioka, H Sashiwa, H Saimoto, et al. (1993) Effects of chitosan on open wound healing, in Carbohydrates and Carbohydrate Polymers, Analysis, Biotechnology, Modification, Antiviral, Biomedical and Other Applications. M Yalpani (Eds.), Mount Prospect, ATL Press, USA, pp. 141-152.
30. Rathinamoorthy R, Sasikala L (2011) Polysaccharide fibers in wound management. International Journal of Pharmacy and Pharmaceutical Sciences 3(3): 38-44.

DOI: 10.32474/RRHOAJ.2018.02.000127