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HYDROGELS: AS WOUND DRESSING MATERIALS- A REVIEW

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ABSTRACT

Hydrogels are polymeric crosslinked chains which have capability to store high amount of water content. On the basis of sources, these may be natural, synthetic or hybrid. When these are formed of natural polymers like chitosan, gelatin, cellulose, collagen etc then these are called natural hydrogels. On the other hand, when different synthetic polymers like Poly (vinly alcohol), Poly (l-latic acid) are used to synthesize such hydrogels then these are called synthetic hydrogels. Sometimes, to enhance some of the properties of hydrogels, a blend of synthetic and natural polymers are used to manufacture hydrogels then these are called hybrid hydrogels. Hydrogels are sued in different fields like in tissue engineering, contact lenses, for preventing the erosion of soil, preventing the mixing of oil in water in the zones of oils,as wound dressing material and so on. This review article highlights the properties of hydrogels which make them suitable for wound dressing.

KEYWORDS: ***Hydrogels, wound, skin, polymers, crosslinking.***

INTRODUCTION:

Hydrogels are three-dimensional polymer networks that can retain a large amount of water in their swollen state.[1-3] Due to their high-water content, the properties of hydrogels resemble those of biological tissues, resulting in excellent biocompatibility. Furthermore, their soft and rubbery nature minimizes inflammatory reactions of the surrounding cells, making them an ideal candidate for biomedical applications.

The interactions responsible for the water sorption include capillary, osmotic, and hydration forces, which are counterbalanced by the forces exerted by the crosslinking in polymer chains that resist the expansion. This cross-

linking is done chemically by forming covalent bonds, physically employing noncovalent interactions, or combining both.[1-3] Moreover, the equilibrium swollen state depends on the magnitudes of these opposing forces and determines the properties (such as internal transport and diffusion characteristics and mechanical strength) of hydrogels to a large extent.

After their discovery in the 1960s by Wichterle and Lim, hydrogels were first successfully applied as contact lenses. Later, hydrogels were frequently used as systems for the controlled delivery of biologically active agents. These hydrogels facilitate the localized and sustained release of a drug, thereby decreasing the number of administrations, preventing damage to the drug, and allowing for relatively low doses.

SKIN AND THE WOUNDS:

The human body's largest organ, the skin, serves as the body's first line of Défense against environmental physical, chemical, and biological elements. Additionally, skin serves a variety of important roles, such as preventing water loss from the body and regulating body temperature. The epidermis, dermis, and hypodermis are the three layers that make up the normal human skin.

The dynamic and intricate process of wound healing can be broken down into four overlapping and succeeding phases: homeostasis (blood clotting), inflammation, tissue growth, and tissue maturation. Blood platelets begin to adhere to the wound site and one another within the first few minutes following an injury. Platelets become activated and aggregate when they come into touch with collagen, changing their shape to an amorphous one. Additionally, thrombin begins to be generated, which initiates the coagulation cascade. Fibrin is then activated as a result, and it forms a mesh to stop additional bleeding. Additionally, platelets are essential for leukocyte recruitment, the beginning and development of inflammation, and leukocyte migration.

TYPES OF WOUNDS:

Wounds can be categorized into two primary groups: acute wounds and chronic wounds, depending on how the repair process works. Acute wounds are wounds that heal fully, with little to no scarring, and in a matter of 8 to 12 weeks. These wounds are typically brought on by mechanical trauma, such as skin-on-hard-surface contact (such as with knives), gunshot penetration, and surgical incisions. Contrarily, radiation, corrosive chemicals, electricity, and thermal traumas are the principal causes of chemical and burn injuries that result in acute wounds. Conversely, chronic wounds are those that exhibit delayed healing 12 weeks after the initial damage. Repeated tissue assaults, underlying physiological abnormalities like diabetes, poor angiogenesis and innervation, or cellular migration are the main causes of such wounds.

Based on causative etiologist, the Wound Healing Society divides chronic wounds into four distinct categories—pressure ulcers, diabetic ulcers, venous ulcers, and arterial insufficiency ulcers. Although those different non-healing wounds may have different causes, they all share common wound characteristics, such as upregulated level of proteases, elevated pro-inflammatory cytokines, persistent reactive oxygen species (ROS), presence of senescent fibroblast, prolonged infection, as well as dysfunctional and insufficient stem cells.

HYDROGELS AS WOUND DRESSING MATERIALS:

Hydrogel dressings are one the most widely used methods of dressing a wound. Made of roughly 90% water, hydrogels provide adequate moisture which can accelerate healing time. Initially, they were designed to help in regulating fluid exchanges on the surface of the wound. Hydrogels represent a class of materials that are widely used in soft tissue engineering of skin, blood vessel, muscle, and fat. Hydrogels are three-dimensional (3D) networks consisting of physically or chemically crosslinked bonds of hydrophilic polymers. The insoluble hydrophilic structures demonstrate a remarkable potential to absorb wound exudates and allows oxygen diffusion to accelerate healing.

Importantly, hydrogels possess a highly hydrated 3D polymeric network and can bind several-fold more water as compared to their dry weight and can thereby maintain a high moisture level of the wound bed. Due to these unique physical properties, hydrogel networks can be casted into various sizes and shapes. Therefore, hydrogel-based materials are the most suitable dressings to cover skin wounds. Furthermore, hydrogels offer a platform to load cells, antibacterial agents, growth factors, as well as distinct supplementary and biomacromolecules.

With regard to ECM similarity, hydrogels used for wound healing applications should provide a cell-friendly 3D environment to promote tissue regeneration, with or without the presence of cells embedded in the scaffold. Importantly, all hydrogels need to satisfy the basic requirements of biocompatibility in clinical use as well as possess unique physical and mechanical properties suited for skin wound applications. Moreover, they also need to provide the appropriate microenvironment for vessel ingrowth and cellular proliferation.

HYDROGEL DRESSING USES:

- Minor Burns
- Painful Wounds
- Full Thickness Wounds
- Partial Thickness Wounds
- Dry Wounds

- Radiation Damage

TYPES OF HYDROGEL DRESSINGS:

Sheet Hydrogels

Sheet dressings typically can be cut to fit the wound. The gel sits inside a thin mesh which overlaps between the wound and the skin without causing any harm. Other wound dressings can cause harm to the skin around the wound, making sheet hydrogel dressings and ideal choice- especially for those with sensitive skin.

Impregnated Hydrogels

These hydrogels include a separate gel compound that is added onto a gauze pad or strip. These can be laid over the wound, or packed inside if the wound is deeper or even. Note that these can require a secondary dressing to hold everything in place and provide complete protection of the wound.

Amorphous Hydrogels

These are free-flowing dressings which are quite thicker than the other two. Designed to be able to move into the deeper parts of the wound or puncture, amorphous hydrogels are flexible making them ideal for flow into the nooks and crannies of puncture and other deep wounds. While it is the most flexible, it often needs to be covered by a secondary dressing so that it stays put and helpful in the wound surface.

HOW TO APPLY HYDROGEL DRESSINGS:

- Wash your hands very thoroughly
- Remove the dressing from it's packaging. Use clean, sterilized scissors to cut the dressing to a size that will cover the entire burn or wound.
- Slowly peel off the backing of the dressing and lay the dressing over the wound or burn.
- Use a fixing tape or other bandage to wrap and hold the dressing in place.

ADVANTAGES OF HYDROGELS:

Hydrogel dressings are in many respects ideal for wound dressings. When applied to dry wounds, as well as sloughing or necrotic wounds, they can make and keep them clean by promoting the removal of infected or necrotic tissue via autolysis.

Hydrogel dressings keep the wound warm, moist, and close. Also, they do not react with or irritate tissue. When applied, they do not adhere to wound surfaces and allow metabolites to pass freely. These dressings help provide a cooling effect on the wound, which makes them very pleasant for patients.

They promote wound reepithelialization as they partially mimic skin structure and encourage the growth of skin components. Also, they can be used to incorporate drugs which enhance wound healing. Lastly, they are suitable for treating all types and stages of wounds except in the presence of heavy exudate, including painful wounds, partial and full-thickness wounds, radiation wounds, minor burns and dry wounds.

DISADVANTAGES OF HYDROGELS:

Hydrogels cannot absorb large amounts of fluid and therefore are not suitable for very wet wounds which could become macerated and infected. Also, their low mechanical strength makes them liable to tearing easily which may make it difficult for patients to change their own dressings.

CONCLUSION:

The hydrogels are those materials which mimic the skin tissues and thus used for wound dressing materials. Since, these are capable of storing high amount of water, these keep the wounds moist which helps in healing of the wounds in lesser period of time. But every material has some disadvantages too. These hydrogels require a adhesive material in addition on the wounds. Some of the self- adhesive materials are also produced but the adhesive properties of such hydrogels still require for more advancement to make them suitable for wound dressing. Thus, hydrogels are suitable materials for wound dressing with a little disadvantage.

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