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REVIEW LITERATURE ON USE OF NILE TILAPIA FISH SKIN IN TREATMENT OF BURN WOUNDS

Gummi Pooja Reddy[1]*, Palem Venkata Suresh[1], Komathi Subramanyam[1] and Penugonda Praval Reddy[2]

[1]Department of Pharmacy Practice, Bhaskar Pharmacy College.

[2]Jawaharlal Nehru Technological University, Hyderabad, Telangana, India-500075.

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***Corresponding Author**
Dr. Gummi Pooja Reddy
Department of Pharmacy Practice, Bhaskar Pharmacy College.

ABSTRACT

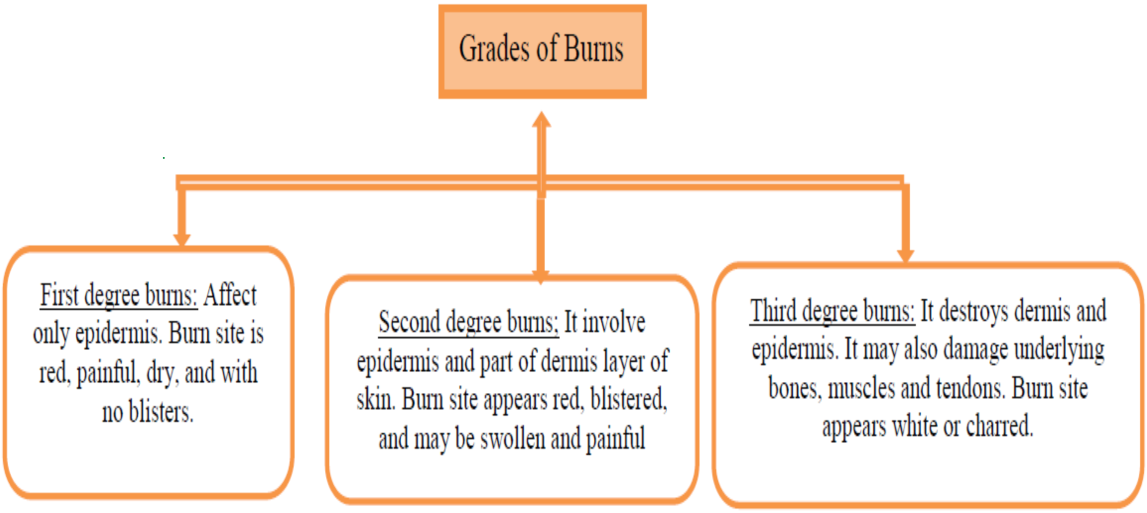
Nile Tilapia is the first aquatic animal skin in the world to be tested in burn patients. Its morphology is much similar to that of the human skin. It adheres to the wound and creates a buffer effect. It blocks outside contamination. It prevents loss of moisture and proteins from the wound and it stays bonded to the wound bed until it heals over. Fish skin contains collagen type-I and type-III in large quantities, a protein that promotes the wound healing process. It has been used as a biological wound dressing for the first time in the treatment of second and third-degree burns. No dressing changes were required as frequently as the gauze. Fish skin dressing enhanced the wound healing process and also reduced the need for pain medications. Fish skin dressing also possesses numerous amino acids in its collagen structure, such as proline and alanine, the presence of amino acids will enhance the proliferation of fibroblasts, granulation tissue formation, and collagen synthesis in the wound.[1]

KEYWORDS: Burn wounds, Fish skin, Collagen, Healing, Dressing changes, Analgesics.

INTRODUCTION

Burns are cutaneous lesions that may occur due to trauma of thermal origin or radiation, electricity, friction, or contact with chemicals, which may be beyond the skin, bones, and tendons.

Burns can be differentiated by their type (chemical, thermal, and electricity), and based on the depth of burn and amount of skin affected[2] burns are divided into 1st grade, 2nd grade & 3rd grade.[3] Burn severity can be determined by the depth and surface area of the burn.



Treatment for burns[4]

Even the burn patients have the same priorities as all the other trauma patients. At first, assess the patient by checking his airway, breathing (check for inhalation and rapid airway compromise), circulation (fluid replacement), disability (compartment syndrome), and exposure to know the percentage area of the burn.

In children basis of the burn, treatment is formed by the prevention of infection and moist wound environment promotion. Superficial partial-thickness burns can be healed completely within 7-14 days whereas deep dermal burns can take up to 4-6 weeks. According to a research study conducted by Lima Junior et al,[5] complete healing of the burn wound is expected within 2 weeks for superficial partial-thickness burns and usually takes longer than 3 weeks for deep partial-thickness burns.

Treatment modalities for burn wounds include silver-containing creams, such as silver sulfadiazine, and biological dressings, such as amnion membrane, human allograft skin, and xenografts. Silver-containing dressings, semisynthetic and synthetic dressings, enzymatic debridement, and surgery are other possibilities.[5]

Deep second and third-degree (full-thickness) burns require skin graft surgery for quick healing and minimal scarring. Skin grafting is a surgical procedure done by removal of injured tissue, selection of a donor site (an area from which healthy skin is removed and used as cover for the cleaned burned area), harvesting (where the graft is removed from the donor site), placing and securing the skin graft over the surgically-cleaned wound so it can heal. Skin substitutes are considered as an alternative occlusive dressing in the treatment of superficial burns as they reduce the frequency of dressing replacement.

Types of skin grafts[6]

Allograft: Allograft is human cadaver skin donated for medical use.

Xenograft: Xenograft is skin taken from a variety of animals, usually pigs.

Autograft: Skin taken from the person burned, which is used to cover wounds permanently.

Sheet graft: Piece of donor skin harvested from an unburned area of the body.

Allografts and xenografts are equally effective, but xenografts are considered a superior choice because of their enhanced safety and reduced price. Allografts and xenografts are used for temporary wound coverings whereas autografts and sheet grafts are used for permanent wound coverings.[7]

Role of collagen in wound healing

Collagen is a fibrous non-branched chain protein in the extracellular matrix which plays a vital role in maintaining tissue homeostasis, biological integrity, and structural mechanics. It forms a bed for inflammatory cytokines and other growth factors in initiating the wound healing process by acting as a scaffold at the site of injury.[8] Collagen dressings are widely used because of their beneficial properties like low antigenicity, enhanced inflammation and hemostasis, accelerated fibroplasia, and epithelization. Collagen dressings are usually derived from animals like cattle and pigskin or chicken waste, but these are inappropriate because of disease transmission risk or religious and cultural reasons.

Marine fish skin contains a good source of collagen. Marine fish skin possesses antibacterial and antioxidant properties which makes it less common for disease transmission and infections. The presence of collagen peptides and omega-3 polyunsaturated fatty acids is responsible for antibacterial and antioxidant properties.

Collagen accelerates the blood coagulation process where conversion of fibrinogen to fibrin, capturing platelets and clots formation occurs by involving in the activation and adhesion of platelets. Collagen acts as a hemostatic agent where it plays a crucial role at wound interfaces by protecting the wound from environmental factors, preserving epithelial cells, and increasing the production and permeation of fibroblasts. Collagen contains the amino acid Arginine in its structure which plays an important role in the healing process of wounds, reducing stress in tissues and it also increases the interactions between the collagen and platelets. In a research study, some investigations were performed on tilapia fish skin collagen sponges to identify the hemostatic properties where these collagen sponges were cross-linked with various cross-linking agents. Results of this research study revealed that collagen sponges have shorter blood coagulation time due to platelet activation by collagen. This cross-linking process however did not alter coagulation time and no difference was spotted between cross-linked and uncross-linked collagen sponges.[9]

Nile tilapia fish skin (NTFS) for burns management

The Nile tilapia (Oreochromis niloticus) belongs to the family- Cichlidae, which originates from the basin of Nile River in East Africa and is widely distributed in tropical and subtropical regions.[10] It is Brazil's most cultivated fish ranks fourth worldwide in United Nations Food and Agriculture Organization (FAO). In Brazil, frog skin was previously used in treating burn wounds, but it was never registered by the National Sanitary Surveillance Agency (ANVISA). Tilapia skin is a readily available, quality, safe, inexpensive material that is easy to apply.[11] Tilapia skin possesses non-infectious microbiota, high amounts of type I collagen, and a similar morphological structure to human skin, so it has been suggested as a potential xenograft for the management of burn wounds.[12] The Colony Forming Units found in samples of Nile tilapia fish skin (NTFS) before the process of chemical sterilization indicated the presence of large composition of type I collagen, a morphology similar to human skin, and high resistance and tensile extension at the break.[13] NTFS contains a large composition of type I collagen, which is morphologically similar to human skin and it also possesses high tensile strength.[14]

NTFS was subjected to chemical sterilization, glycerolization, and irradiation. Irradiation is then followed by microbiological tests for bacteria and fungi, before its storage in a refrigerator for sterile packaging. It should be washed with 0.9% saline for 5 minutes before its use in patients. Standard sterilization techniques must eliminate the harmful pathogens but should preserve the structural and biochemical properties that could compromise the dressing function. Sterilization can be done by different procedures which include the use of; chlorhexidine gluconate (CHG), povidone-iodine (PVP-I), and silver nanoparticles (AgNPs).

A research study revealed that silver nanoparticles are more efficient in reducing microbial counts and also did not impair cellular structure or collagen fibers content in fish skin, which makes it an ideal sterilizing agent for the chemical sterilization process. This study also revealed that CHG and PVP-I cause alterations in the collagen content. These findings from this study provide an efficient and quick sterilization method suitable for tilapia fish skin that could be used as a biological dressing.[15]

After sterilization, the sterilized fish skin can last up to 2 years. The treatment process removes the fishy odor. The treatment of burn wounds with the fish skin can be done by covering the burned part of the patient's skin with the sterilized fish skin, followed by covering it with a bandage. No cream is required during the bandage application process. Remove the bandage after about 10 days where the fish skin becomes dry and the loosened burn can be shelled with the hand. The use of fish skin in burns treatment accelerates the healing process, reducing the use of the medications thus lowering the treatment cost. NTFS closely resembles the human skin so it easily gets adhered to the burned area which was affected hence there is no need to perform regular wound dressing changes. Hence it causes less pain and discomfort to the patient.[10]

A research study was conducted by E.M. Lima-Junior et al, where a 23-year-old male patient with no co-morbidities arrived at a burn treatment center after a thermal injury caused by contact with flames from a gunpowder explosion. The patient suffered from superficial partial-thickness burns to his right upper limb and deep partial-thickness burns to his left upper limb, face, and anterior and posterior thorax. 16% of total body surface area got involved. The patient was later resuscitated with the IV fluids after admitting into the hospital as an inpatient and remained hemodynamically stable.

The patient was submitted to anesthesia and analgesia with 150 mg of ketamine, 10 mg of midazolam, and 200 mg of tramadol. At first, the lesion is cleaned with tap water and 2% chlorhexidine gluconate. Then it is followed by the removal of necrotic and fibrinous tissue from the burn wound then the biomaterial- Nile tilapia fish skin was applied to the upper limbs of the patient. The fish skin was applied in a way such that at least 1cm of healthy skin in the borders of the wound should be covered to ensure eventual movement in the first days of treatment will not lead to uncovering of any area of the burn. The gauze and bandage of the upper limbs were changed every 72 hours for the first week. It is done to evaluate the NTFS adherence to the human skin. However, the results showed good adherence to the wound bed with no need for dressing changes. No dressing changes were needed in the areas covered with NTFS, due to its good adherence to the wound bed, suggesting its potential in reducing burn patient pain, hospital costs, and overall workload of the health care team.

NTFS had a dried and hardened appearance on the 12th day of treatment and it started to slough off from the patient's right upper limb. This proves to remove the NTFS skin from the burn wound area. NTFS was removed from the patient's limb by placing his limb under a shower and the wound was soaked with water. Dressing removal of the NTFS can be done either by the hydration process or by digital separation. The hydration process led to weakening, breaking, and slippage of tilapia skin, with exposure of underlying healed skin. Digital separation of NTFS from burn wounds can be done with the aid of petrolatum jelly. On the 17th day of treatment, a similar process was performed, allowing NTFS removal from the left upper limb. No side effects were noted.[15]

CONCLUSION

The fish skin dressing accelerates the wound healing process and efficiently inhibited the local microbial activity, and also, exuberant granulation tissue formation. No frequent dressing changes were needed, which reduces the wound dressing number may alleviate pain and stress associated with dressing change each time especially in chronic wounds.

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