Our Experience in Chronic Wounds Care with Polyurethane Foam

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Polyurethane foam has numerous applications, from furniture to medical field. As a wound dressing creates a moisture environment that promotes epithelialization and diminishes pain. A prospective study was realized to evaluate polyurethane foam efficacy in treating chronic wounds due to venous, arterial or diabetic causes. Our evaluation showed good results with an accelerated epithelialization.

Keywords: polyurethane foam, chronic wounds, diabetic wounds, moist dressing

The management of treating patients with chronic wounds varies from one patient to another depending on the response and the evolution under treatment. Chronic wounds are defined as wounds that do not follow the normal stages in wound healing and do not cure in the usual period of time, generally considered three months [1,2]. The pathology of a chronic wound is associated with blockage of wound healing in the inflammatory stage as a result of uncontrolled levels of proinflammatory factors, infection, hypoxic medium and an inadequacy level of stem cells [3,4]. Even if there are common characteristics in chronic wounds evolution, these differ at molecular level [1] and are classified in four categories: diabetic foot ulcers, arterial and venous insufficiency ulcers and pressure ulcers [2]. Another important element in the pathology of chronic wounds that is also an external factor that must be taken into consideration in healing, is the presence of the bacterial biofilm [5,6]. The biofilm is adherent to the wound surface creating a barrier for antimicrobial agents, which delay healing, with improper epithelialization and granulation tissue formation [7].

Chronic wounds can produce excessive exudate that worsens proper healing causing effusion, skin complications, electrolyte disproportion or infection. However, a lower quantity of exudate delays the epithelialization and produce pain when the dressing is removed. So, after a good debridement and proper irrigation, a moist environment must be maintained [8]. The moist environment determines the migration of macrophages, keratinocytes, fibroblasts and endothelial cells, all involved in granulation and reepithelialization [9].

Wound dressings are essential in the standard of care, controlling the moisture balance of the wound. These should act as a gas-permeable barrier against germs, absorbing the exudates without drying out the surface of the wound, creating a moist environment and reducing pain during the healing process [8]. More and more synthetic wound dressings are created having new benefits in the process of healing. The use of these dressings depends on the stage and the morphology of the ulcer, the presence of bacteria and/or necrosis [10].

Polyurethane foam dressing is an example of dressing with the characteristics highlighted above that form a moist environment, absorbing the excess of exudate and debris from the chronic wound [11].

Experimental part

We realized a prospective study including sixteen patients with chronic wounds that were treated in the Plastic Surgery Department of Emergency Clinical Hospital Prof. Dr. Agrippa Ionescu during a period of eight months. Inclusion criteria were chronic wounds older than 3 months in patients with diabetes or vascular pathology. Patients with uncontrolled glycemia, with hemoglobin value less than 12 mg/dL, with allergy or hypersensitivity to polyurethane foam and pregnant women were not included in the study. Local ethical agreement and informed consent of the patient were obtained.

Blood tests and bacterial wound cultures were completed at admission. Considering that patients with chronic wounds have a poor nutritional status, an evaluation of albumin and total proteins was also realized to every patient. In patients with severe infection signs as cellulite described by edema, warmth and pain and leukocytosis, an empirical antibiotic was started in comparison with the other patients where antibiotic was only administered after the antibiogram result.

At admission the first step was to irrigate the wounds with saline solution in order to remove the detritus, bacteria and any previous treatment. An antiseptic dressing was also applied, being changed daily until the result of the bacterial wound culture was ready. Patients with sterile wound cultures were treated with polyurethane foam after debridement and cleaning with betadine soap and saline solution. Antibiotic therapy was started considering the antibiogram result in patients with positive wound cultures. After sterilizing the wounds, polyurethane foam was also applied and was changed every three days.

Every week the wound dimensions were evaluated and wound cultures were repeated.

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Results and discussions

Eight enrolled patients had diabetic ulcers; six had venous ulcers and two of them arterial ulcers. In two patients, with diabetes mellitus ulcers, we started empirical antibioterapy due to severe signs of infection. Polyurethane foam was applied after 3 days from admission in 6 out of 16 patients with sterile wound cultures, and after a 5 days antibiotic therapy in the other 10 patients.

Patients with venous ulcers had a faster epithelialization start, after the second dressing in comparison with arterial ulcers where epithelialization started after the third dressing. Pain was diminished and patients were satisfied about the lack of necessity of daily dressing. Constant measures showed that a new epithelium grew with 1 cm^2 after every dressing in patients with venous ulcers and with 0.8 cm^2 in patients with arterial ulcers. Diabetic ulcers had a longer evolution with a delay in epithelialization, having only 0.5 cm^2 of epithelium advancement after every dressing.

The polyurethane foam promoted a moist environment and prevented wound contamination, the following wound cultures being sterile.

Polyurethanes are made through exothermic reactions that involve polyols and isocyanates [12] (fig. 1). Foamed polyurethanes are formed from the reaction between polyols, isocyanates and water that produces bubbles and foam creating an expanding structure [13].

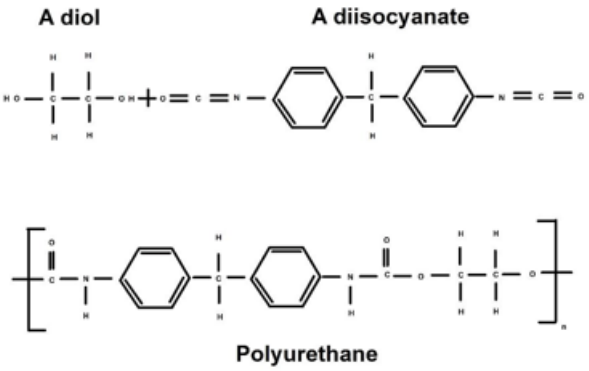

Fig. 1. Polyurethane formula

The polyurethane foam dressing is designed as a hydrophilic structure, formed by a polymeric film that encapsulates foam chips [10,11]. It has three layers: one for protection, one for absorption and one that comes in contact with the wound. The outer layer is gas-permeable, waterproof and germ resistant. The inner layer, the wound contact layer, has micropores that block the new epithelial cells to grow into the dressing preventing skin adherence and reducing the pain when the dressing is changed [14]. The most important layer is the middle one, the absorption layer that creates a moist wound environment that stimulates wound healing as well as avoiding leakage of exudates [15,16]. Moreover, the polyurethane foam dressings have the potential of autolytic debridement, without leaving residuals or deteriorate. Also, it prevents odors and stains [10].

In all the healing period wound cultures remained sterile and there was no bacterial biofilm formation due to germ resistant layer of the dressing. An important role was also played by the inner layer of the dressing that did not permit the adherence to the wound surface, the patients having no pain at dressing removal with a general pain and discomfort decreased daily. The patients did not accuse any leakage of exudate during all the period of treatment with polyurethane foam highlighting the fact that the middle layer of the dressing absorbed the excess of liquids. In addition, even if all the exudate was absorbed by the dressing the wounds did not become dried. So, a moist environment was created to protect and heal the wounds. Polyurethane foam does not have a universal application because is not suitable for dry wounds or with minimum exudate [16].

In diabetic patients the healing process was more complex due to all the molecular problems. Even if the proceedings were the same, the epithelialization and granulation tissue formation had a longer evolution. The factors involved in the healing process, such as growth factor, formation of new blood vessels, macrophage, keratinocyte and fibroblast function, are reduced or disproportioned. The keratinocytes present an incomplete differentiation and hyperproliferation and the fibroblasts a phenotypic change with reduced migration and proliferation [17]. In these patients a longer debridement was performed to eliminate the hyperkeratotic tissue. The dressing was changed every two days until the granulation tissue started to form.

Conclusions

Wound dressings have evolved through years, facilitating also wound healing than just covering. Nowadays modern wounds dressing are based on synthetic polymers with different active proprieties. One of these interactive dressing is polyurethane foam, that keeps hydration, prevent contamination and promotes wound healing. Also it reduces local pain, increasing patient's toleration and quality of life.

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