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Research Article

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Chemical Debridement of a Dry Escar in a Pediatric Patient Resulting from an Electrical Burn on the Scalp

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ABSTRACT

The primary objective of this research was to identify the debridement effect of a chemical product, Acetic Acid, applied to a dry eschar from a pediatric patient resulting from an electrical burn on the scalp, evaluating its effect at 24, 48, and 72 hours after application. The research was applied, quantitative, a clinical case study, with an experimental, quasi-experimental laboratory, and longitudinal design. Data were collected by the researchers through direct observation performed by the Pathological Anatomy team of the Coromoto Hospital in Maracaibo, Zulia State, Venezuela. The information was processed using a visual-descriptive qualitative analysis, supported by a chronological comparison of images and a description of the microscopic findings. The results obtained from the microscopic examination during the first 24 hours using the chemical product showed skin and subcutaneous tissue with an ulcer and dermo-epidermal sclerosis. At 48 hours, the skin showed an ulceronecrotic plaque, an absence of skin appendages with sclerosis of hair follicles, and at 72 hours, skin with severe dermo-epidermal sclerosis lined by a fibrin-leukocyte plaque. This allows us to conclude that the use of a chemical product (Acetic Acid) produces debridement in an eschar resulting from an electrical burn starting 24 hours after its application, increasing its effect at 72 hours.

Keywords: Debridement, Chemical, Acetic Acid, Burn, Electric

Introduction

Burns: A Global Public Health Problem

According to the burns constitute a global public health problem, causing approximately 180,000 deaths per year, the majority of which occur in low-income countries compared to countries with a higher annual GDP [1]. In 2000, the direct costs of medical care for burned children in the United States of America exceeded US$211 million. A burn is the consequence of trauma affecting tissues due to contact with a physical, chemical, or biological agent. These thermal injuries can be minor medical problems or constitute potentially fatal emergencies.

In Norway, the costs of hospital burn management exceeded 10.5 million Euros in 2007. To this, indirect costs must be added, such as lost wages, prolonged care for deformities and emotional trauma, as well as the use of family resources and subsequent rehabilitation, all of which are factors contributing to the socioeconomic impact. Therefore, the exact prevalence and incidence in Venezuela are not precise; however, being an oil and mining country, it is at high risk for the prevalence of burn accidents and incidents. It is estimated that annually between 800 to 1000 people suffer injuries from physical, chemical, or biological agents.

The management of burn patients requires an interdisciplinary team, consisting of specialists in reconstructive surgery, intensivists, traumatology, imaging, nutritionists, nursing staff in intensive and surgical care, and even psychological support. This makes the burn patient a complex and interconnected process aimed at preserving life, especially if the injuries are extensive

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and deep. Burns can be identified by their extent and depth, as well as the agent that causes them. Among the most serious burns are those affecting the full thickness of the skin, generating significant damage that requires more complex treatment. In this sense, type B or third-degree burns are the most difficult to treat.

One of the semiological characteristics that identify third-degree or type B burns is their whitish or dark brown coloration with a characteristic palpation feel similar to cardboard. This indicates that the tissue is completely devitalized and must be debrided to establish and initiate effective treatment on healthy tissue to achieve total epithelialization of the defect or through surgical techniques. These eschars can be removed surgically using techniques such as tangential excision or escharectomy. However, techniques using certain products based on proteases and other components that have a chemical effect function to degrade devitalized tissue and expose healthy tissue for subsequent treatment are described. This is known as chemical debridement and is a non-surgical alternative to remove eschars resulting from type B or third-degree burns. Thus, chemical debridement is a fast and more economical option to remove devitalized tissue resulting from type B or third-degree burns, reducing potential complications related to a surgical procedure, as well as the possibility of obtaining regeneration of healthy tissue by removing the devitalized layer.

Wound debridement is crucial for effective wound treatment and is essential for removing necrotic tissue, reducing bacterial load, and promoting granulation. Although surgical debridement is common, it can be traumatic and potentially delay healing by enlarging the wound area. Recent scientific literature (2019-2024) strongly supports the use of acetic acid as an effective topical antimicrobial agent in the management of wounds and burns, with a particular effect on bacterial biofilms. Its primary role is that of indirect or autolytic debridement. By effectively eliminating bacteria and disrupting biofilms, it reduces infection and inflammation, allowing the body's own enzymatic mechanisms (autolysis) to remove devitalized tissue. Furthermore, its protein-denaturing action may contribute to softening the eschar.

According to who analyzes the current evidence on the use of acetic acid in wound management, concludes that despite its historical use, high- quality evidence is limited, but it shows efficacy against a wide range of gram- negative and gram-positive bacteria, including resistant strains [2]. Its potential to disrupt biofilms is highlighted, which indirectly favors autolytic debridement. For his part, in a network meta-analysis comparing the efficacy of various topical agents for burns, includes data on acetic acid, finding it to be an effective and low-cost option for reducing bacterial load, particularly against Pseudomonas aeruginosa, a common pathogen in burns. Its action helps prepare the wound bed for healing [3]. in a case series, demonstrates the practical application of topical acetic acid (0.5% - 1% solution) in complex wounds with signs of local infection. The authors report a reduction in exudate, odor, and bioburden, which facilitated subsequent debridement and promoted granulation [4]. This is applicable to the context of burn eschars. in an in vitro study, investigates the mechanism of action of acetic acid on bacterial biofilms of Staphylococcus aureus and Pseudomonas aeruginosa. It demonstrates that low concentrations (0.5-1%) are capable of penetrating and disrupting the biofilm matrix, reducing bacterial viability [5].

This is crucial for the debridement of colonized devitalized tissue. conducts a systematic review evaluating the effectiveness of various topical antimicrobial agents [6]. Although the specific evidence for acetic acid is less robust than for silver sulfadiazine, it is identified as a viable alternative, especially in resource-limited settings or for controlling infections caused by resistant bacteria, thereby facilitating an environment conducive to autolysis. their review focuses specifically on the role of acetic acid in managing wound biofilms. It synthesizes evidence supporting its use to "debride" the wound microbiologically, removing the barrier that the biofilm represents to healing and the action of other debriding agents [7]. in a murine model study comparing the impact of different antiseptics, including acetic acid, shows that while it is effective against pathogens, its prolonged use may affect the beneficial skin microbiome [8].

It suggests a tactical and short-term use to control infection and allow natural debridement processes to take place. in a study evaluating the use of acetic acid-impregnated gauzes in chronic wounds, reports improvements in clinical signs of infection and a reduction in treatment costs compared to other, more expensive topical agents. Debridement is achieved indirectly by controlling infection [9]. in research evaluating the efficacy of topical acetic acid against multidrug-resistant organisms (MDRO) isolated from wounds, finds that it is highly effective in vitro, supporting its use as part of a comprehensive debridement strategy for complicated wounds, such as infected burns [10]. For his part, summarizes the role of acetic acid in the management of burn infections. It discusses its mechanism of action, effective concentrations (typically 0.5% - 5%), and its safety profile. It concludes that it is a valuable agent, particularly for controlling Pseudomonas, which helps create a more manageable environment for surgical or autolytic debridement [11].

Materials and Methods

This research was situated within the line of Health Sciences, specifically in the area of Caumatology or Burn Medicine, having a rationalist-deductive epistemological approach, as well as positivist, based on the principles established in the Declaration of Helsinki. Based on the objectives of the present study and according to the research method, it is applied and explanatory. The research design was observational, laboratory experimental, pre-experimental with multiple measurements over time; it refers to performing an action and then observing the consequences, thus describing the phenomenon within a study population. According to its evolution, it has a longitudinal focus, as it examines the same people or units of analysis at multiple points over time, allowing for the analysis of the evolution of a phenomenon, observation of individual changes, and evaluation of the relationship between variables over time. The sample selection was performed by intentional non-probabilistic sampling.

Two (2) scalp skin resections from an 8-year-old pediatric patient, resulting from an electrical shock burn with the following

dimensions, 7.5x2.5 cm and a second tissue of 7.5x3.5 cm, were sent to the Pathological Anatomy Service. The macroscopic appearance showed a cutaneous surface with discretely excavated blackish ulcerative areas, with the presence of hair. The opposite side was whitish-gray with purplish areas. Different cuts were made to obtain control samples, fixed in 10% formalin for 24 hours without any additives, included, and histopathological sections were made stained with Hematoxylin/Eosin (H/E).

Tissue Samples

The two eschar samples were transported in sterile saline solution. Each sample was divided into multiple 1 cm^2 fragments for random assignment to treatment groups.

Solution Preparation

- **Acetic Acid:** A 1% (v/v) acetic acid solution in sterile distilled water was prepared.
- **Control:** Sterile saline solution (0.9% NaCl).

Intervention Groups

1. **Control Group (CT):** Sterile saline solution.
2. **Acetic Acid Group (AA):** 1% acetic acid solution.

Application Protocol

The application volume was standardized at 100 µL per square centimeter of tissue (100 µL/cm^2), according to established conventions to ensure complete and uniform coverage without causing runoff. Precise volumes were dispensed using an Eppendorf Research® 100-1000 µL automatic pipette with sterile tips. After application, the fragments were placed in individual sterile Petri dishes and incubated at 37°C to simulate body temperature.

Macroscopic Study 24 hours

- Three (3) random location cuts were made.
- The corresponding chemical product (Acetic Acid) was added. Diffuse color change to light gray is observed.
- All fragments were fixed in formalin after 24 hours, and histopathological sections were made and stained with H/E.

Macroscopic Study 48 hours

- Three (3) random location cuts were made.
- The corresponding chemical product (Acetic Acid) was added, color changes are observed, blackish-brown, with a cardboard-like consistency upon cutting.

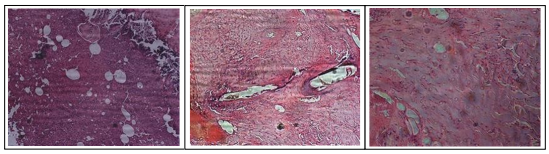
Macroscopic Study 72 hours

- Three (3) random location cuts were made.
- The corresponding chemical product (Acetic Acid) was added, a blackish, cardboard-like consistency is observed, solid and blackish upon cutting.

Microscopic Study

Control Scalp Skin

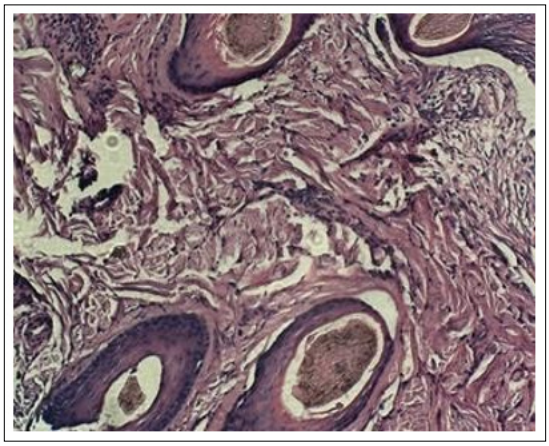
A fragment of scalp skin previously fixed in 10% formalin for 24 hours was included, a histological slide stained with H/E was made, observing widely and severely ulcerated, excavated skin and subcutaneous tissue, lined by fibrin- leukocyte crusts with an absence of eccrine skin appendages in the dermis, the latter with extensive sclerosis and coagulative necrosis, showing hair follicles with sclerosis of the bulb.



Microscopic Study 24 hours

Fragments of skin subjected only to the chemical product, two (2) drops on its cutaneous side, were included. After 24 hours, it was fixed in 10% formalin for 24 hours, then histopathological sections were made and stained with H/E, observing:

Chemical Product (Acetic Acid): Skin and subcutaneous tissue with an ulcer and dermo-epidermal sclerosis that includes muscle tissue and subcutaneous fat.

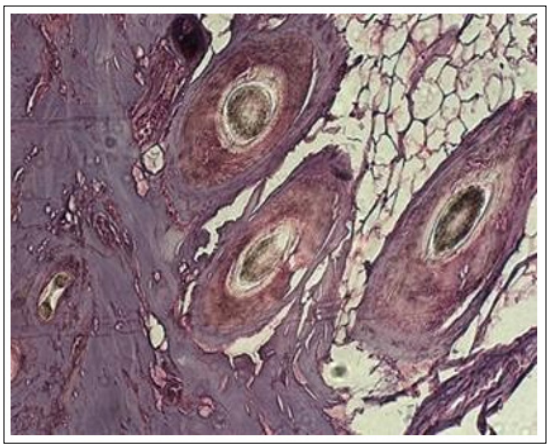


Microscopic Study 48 hours.

Fragments of skin subjected only to the chemical product, two (2) drops on its cutaneous side, were included. After 48 hours, it was fixed in 10% formalin for 24 hours, then histopathological sections were made and stained with H/E, observing:

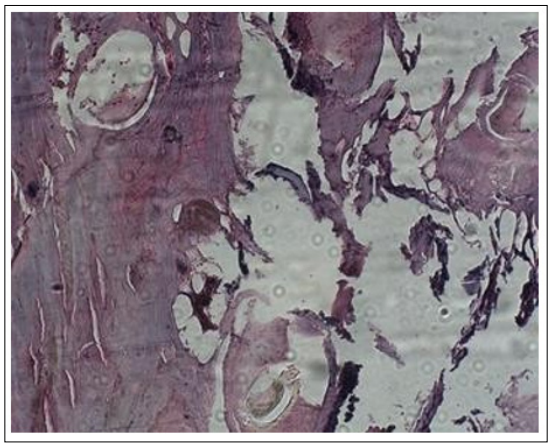
Chemical Product (Acetic Acid): Skin with an ulceronecrotic plaque, absence of skin appendages with sclerosis of hair follicles.

Microscopic Study 72 hours.



Fragments of skin subjected only to the chemical product, two (2) drops on its cutaneous side, were included. After 72 hours, it was fixed in 10% formalin for 24 hours, then histopathological sections were made and stained with H/E, observing:

Chemical Product (Acetic Acid): Severely ulcerated skin with marked dermo-epidermal sclerosis, subcutaneous tissue, and hair follicles.



Study Population and Sample Inclusion Criteria

- Eschar on the scalp in the interparietal and occipital region, resulting from an electrical burn. Type B burn according to depth, full thickness.
- Sample taken from a 9-year-old male pediatric patient who suffered an electrical shock burn type ABB and B on 10% of the burned body surface area.

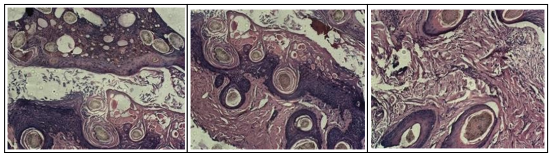
Exclusion Criteria

- Type A, ABA, or ABB burns caused by other agents.

Results

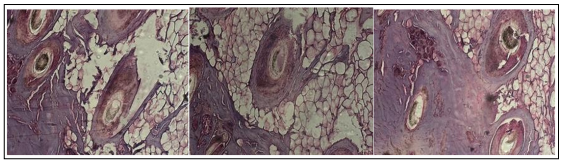
Microscopic Study 24 hours.

Chemical Product (Acetic Acid): Skin and subcutaneous tissue with an ulcer and dermo-epidermal sclerosis that includes muscle tissue and subcutaneous fat.



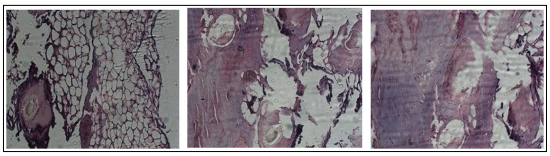
Microscopic Study 48 hours.

Chemical Product (Acetic Acid): Skin with an ulceronecrotic plaque, absence of skin appendages with sclerosis of hair follicles.



Microscopic Study 72 hours.

Chemical Product (Acetic Acid): Severely ulcerated skin with marked dermo-epidermal sclerosis, subcutaneous tissue, and hair follicles.



This allows us to conclude that the use of a chemical product (Acetic Acid) produces debridement in an eschar resulting from an electrical burn starting 24 hours after its application, increasing its effect at 48 and 72 hours. This opens the option for new research with eschars produced by agents such as hot liquids, hot metals, and even of chemical origin to identify if the effect is similar to that obtained in this research. This finding allows us to infer that the tested product reveals a proven level of effectiveness within the first 24 hours, which could make it a therapeutic option for the degradation of full-thickness eschars or type B burns, without the need to subject the patient to a potential surgical procedure to resect these lesions.

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