

EFFICACY OF DIPHOTERINE HCl DECONTAMINATION IN RATS : A COMPARATIVE STUDY

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ABSTRACT

Introduction: Chemical burns are common and a variety of decontamination solutions have been used clinically. This study compared the effects of saline solution, calcium gluconate, and Diphoterine® (an amphoteric, hypertonic, polyvalent chelating decontamination solution) on immunological responses, analgesic responses, and wound healing following experimental 0.5 ml, 52% hydrochloric acid (HCl) burns in rats.

Materials and Methods: Of 25 male wistar rats, 20 were exposed to 0.5 ml of a 52% HCl solution for 15 seconds on the skin (left shoulder) and after 15 seconds were decontaminated for 30 seconds on the skin with either normal saline solution (n=5), 10% calcium gluconate (n=5), or Diphoterine® (n=5). 5 rats were exposed but not treated; the remaining 5 animals were unexposed controls. Parameters investigated were immunological (IL-6, TNF- α , NO), and analgesic (β -endorphin, substance-P) at 6 and 48 hours and 7 days following exposure. Wound healing was also assessed.

Results: IL-6, TNF- α , NO) were significantly lower in the Diphoterine® group. Animals decontaminated with Diphoterine® had faster resolution of the necrotic area and improved tissue healing as compared to animals decontaminated with the other solutions or controls exposed but not decontaminated.

Discussion: Lower levels of NO in the Diphoterine® group reflects an improved response to infection, whereas higher levels in the normal saline and calcium gluconate groups indicates a response to inflammation/infection (inhibition of leukocytes and macrophages). The lower TNF- α and IL-6 levels in the Diphoterine® and saline solution groups indicates a lesser general inflammatory response. The results of β -endorphin and substance-P indicate that the animals decontaminated with Diphoterine® may have experienced less pain. Wound healing parameters indicated that Diphoterine® was more efficacious as a decontamination solution than either normal saline or calcium gluconate.

Conclusion: Diphoterine®, an amphoteric, hypertonic, polyvalent chelating decontamination solution was superior to normal saline and calcium gluconate for skin decontamination following experimental HCl burns as shown by immunological responses, analgesic effects, and improved wound healing.

INTRODUCTION

Chemical burns are common. Josset et al (1984) noted that there were approximately 7,000 serious chemical burns in France during this year. In the US, the American Association of Poison Control Centers Toxic Exposure Surveillance System (AAPCC TESS) recorded 185,509 dermal and 134,669 ocular exposure cases in 1999 (8.0% and 1.3% of total reported exposures, respectively). Of these, 3,243 involved hydrochloric acid (HCl) and 9,104 involved all acids (excluding hydrofluoric acid HF). Of the HCl cases, 1,229 cases (38%) were evaluated in a health care facility, as were 41% of all acid exposure cases. In the HCl cases with known outcome, 14% were asymptomatic, 86% had any symptoms, <1% had major symptoms, and there were 3 deaths. Of all acid (excluding HF) cases, 15% were asymptomatic, 85% had any symptoms, <1% had major symptoms, and there were 6 deaths. Diphoterine® is an amphoteric, slightly hypertonic, polyvalent chelating water-soluble compound used as an eye/skin decontamination solution for a wide range of chemical compounds, including bases and acids. This experimental study was performed to assess the comparative efficacy of Diphoterine® versus isotonic normal saline decontamination in a rat HCl burn model. Because hydrochloric acid and hydrofluoric acid exposures have sometimes been confused, Diphoterine® was also compared to calcium gluconate decontamination.

MATERIALS AND METHODS

Animals/Decontamination:

- * 25 male Wistar rats, average weight 250 grams
- * Groups (N=5/group)
 - - 5 controls (no HCl exposure/no decontamination)
 - - 5 HCl-exposed, no decontamination,
 - 5 HCl-exposed, decontaminated for 30 seconds with normal saline,
 - 5 HCl-exposed, decontaminated for 30 seconds with 10% calcium gluconate solution,
 - 5 HCl-exposed, decontaminated for 30 seconds with Diphoterine®

Anesthesia:

- * General anesthesia with 30mg/Kg ketamine during HCl exposure
- * General anesthesia with ether during blood drawing

HCl exposure :

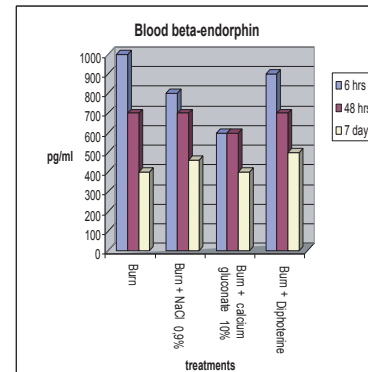
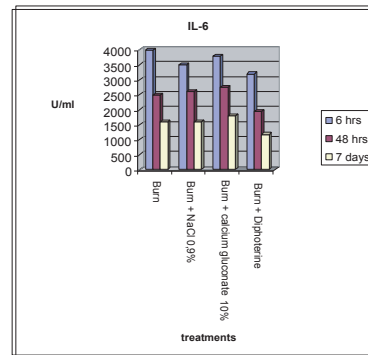
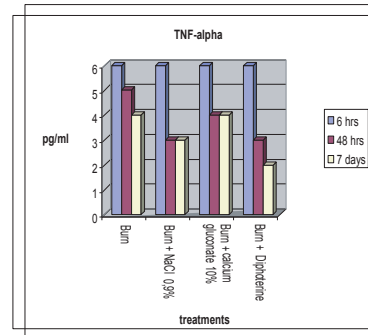
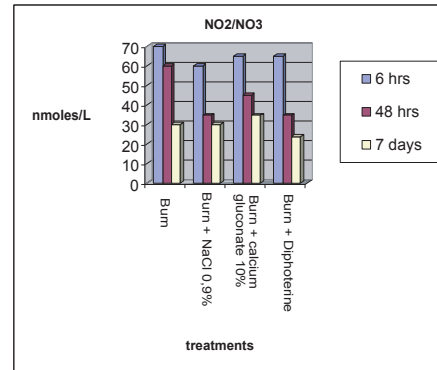
- * 52% HCl, 0.5 ml instilled on the left shoulder for 15 seconds

Parameters Assessed at 6, 48 hours and 7 days following HCl exposure:

- * Immunological (Plasma)
 - Interleukin-6 (IL-6)
 - Tumor Necrosis Factor- α (TNF- α)
 - Nitric Oxide (NO)
- * Analgesia (Plasma)
 - β -Endorphin

RESULTS

The results of plasma assays for immunological and analgesia parameters are shown in the following figures.



DISCUSSION

IL-6 and TNF- α production is enhanced during inflammation and following burns. NO levels also increase following a chemical burn due to an inflammatory response to the injury. In this study, the use of Diphoterine® was associated with decreased plasma levels of these parameters at 6 and 48 hours and 7 days after experimental HCl skin burns, as compared to untreated controls and following decontamination with either normal saline or 10% calcium gluconate solution. Chemical burns are acute stress conditions causing release of endogenous opioids such as β -endorphin. When Diphoterine® decontamination was done, there was an increased release of β -endorphin and a decreased release of substance-P, indicating a lesser degree of pain in these animals as opposed to those not decontaminated or decontaminated with either normal saline or 10% calcium gluconate. Improved wound healing in the Diphoterine® decontamination group compared to controls not decontaminated or animals decontaminated with either normal saline or 10% calcium gluconate was shown by a more rapid resolution of the necrotic area and better healing of the burned tissue starting from the external burn margin.

CONCLUSION

Decontamination with Diphoterine® modulated plasma cytokines and opioid peptides in this experimental HCl dermal burn model, as well as promoting better wound healing as compared to no decontamination or decontamination with either normal saline or 10% calcium gluconate. **These data provide further evidence that Diphoterine® represents a more efficacious means of active decontamination of acid dermal splashes.**

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