MOIST EXPOSED BURN THERAPY: EVALUATION OF THE EPITHELIAL REPAIR PROCESS (AN EXPERIMENTAL MODEL)

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SUMMARY. The purpose of this experimental study was to evaluate the efficacy of moist exposed burn ointment (MEBO) on epithelial tissue repair and to assess the debriding effect of partial-thickness burn wounds, compared with other local agents commonly used. Eighty burn wounds on ten Ladrace-Pietrenne youngi pigs were induced by CO₂ laser and the following parameters were evaluated: alterations of the burn wound area using planimetry; physical examination including necrosis, exudation, oedema, and clinical appearance; pH, transepidermal water loss, and moisture of the wound surface; and histological evaluation of burn depth and epithelial repair. Three different local agents (MEBO, povidone iodine, and silver sulphadiazine) were applied twice daily, except in the control group wounds. Evaluation and measurement were performed on days 2, 4, 6, and 8. The following results were found: the measurement of water loss from the wound surface is an objective non-invasive procedure to assess wound healing; MEBO appears to significantly accelerate the healing process in partial-thickness burns, compared with the other local agents; measurement of wound moisture may give additional information regarding the wound healing process; MEBO creates a moisturizing environment for a longer period, which enhances wound healing compared with other substances; planimetry is an efficient method to calculate the burn area and the progress of healing in full-thickness burn wounds only; and there is no relation between pH and wound healing.

Introduction

Many drugs or "medical agents" have been applied to improve and accelerate the wound healing process. The variety of agents used led Ambroise Pare (1510-1590) to postulate that a surgeon's goal in wound management was to create an environment where the healing process could proceed in optimal fashion, and he demonstrated the beneficial effect of the application of hot oil to fresh open wounds. Since then and over the centuries many publications have pointed out that a moist environment enhances epithelialization in the wound healing process. Controlled experimental and clinical data have in recent times supported the suggestion that a moist environment enhances wound healing in the form of an occlusive dressing compared with a dry environment. Xu Rongxiang' has developed the "moist exposed burn therapy" - a therapeutic procedure based on the moist environment of the wound, using an ointment that enhances epithelial repair, and in particular that of
partial-thickness burn wounds. Moist exposed burn ointment (MEBO) consists only of natural ingredients including - apart from honey and sesame oil - 17 amino acids, 14 fatty acids, and 4 polysaccharides. The ointment's main active substance is considered to be B-sitosterol at a concentration of 0.25%. Clinical and experimental investigations by ChuanjiU,4 Yunying,' and Rongxiang' have indicated that MEBO has the following therapeutic effects:

analgesic: MEBO reduces pain in partial-thickness burn wounds;
anti-shock: MEBO reduces evaporation of water from the burn wound surface and improves microcirculation by decreasing peripheral and systemic capillary exudation;
anti-bacterial: MEBO changes the biological behaviour of bacteria, inducing a decrease in bacterial toxicity and invasive capacity, as well as sensitivity to antibiotics; it also increases the wound's local and systemic immunity;
MEBO promotes epithelial repair; it also reduces healing time in partial-thickness burns;
MEBO improves scar formation and contributes to the formation of a smooth, thin, and aesthetically acceptable scar; it thus prevents the formation of hypertrophic scars.

Aim of the study
The aim of this experimental study was to evaluate the efficacy of MEBO on the epithelial tissue repair of partial-thickness burn wounds of different depths, with a view to understanding the action mechanism and in particular to assessing any debriding effect by the ointment.

Material and methods
Ten female, two-month-old Ladrace-Pietrenne pigs were used, weighing between 23 and 25 kg. The animals were caged communally for one week prior to the operation. The pigs were fed a basal diet and drank water ad libitum. The animals were housed in a controlled room temperature of 26-29.

The animals were sedated with ketamine (20 mg/kg body weight) and midazolame (0.5 mg/kg). Endotracheal anaesthesia was induced and maintained with profol (25 mg/kg), fentanyl (2.0 [tg/kg), and pavulon (0.2 mg/kg).

A silk touch CO₂ laser with a round microprocessor scanner (diameter 2 mm) in continuous wave was used to induce the thermal wounds. The depth of the wounds ranged from 0.45 to 2.3 trun, simulating the resurfacing procedure or a partial -thickness burn of various depths (Fig. 1).

Fig. 1 - Experimental procedure to create burn wounds with silk touch CO₂ laser (left). Use of 2 mm round microprocessor scanner (centre). Close-up picture of bum wound .

The following non-invasive objective parameters were evaluated every second day until complete epithelialization of the wounds in order to assess the epithelial repair of the wound:

a. extent: planimetry
b. physical examination: clinical picture of the wound (oedema, necrosis, exudation)
c. other skin attributes: pH of wound surface, transepidermal water loss (TEWL), moisture, histological evaluation of epithelial repair

Experimental protocol
Under general anaesthesia the dorsum of the pig was shaved and washed with povidone iodine scrub followed by sterile saline rinse.

Eight partial-thickness burn wounds of different depths measuring 5 x 5, cm were inflicted on either side of the paravertebral region in each pig (total number of bum wounds: 80) (Fig. 2).

Fig. 2 - The eight bum wounds created paravertebrally with a CO₂ laser.
The left side was treated with MEBO, while the right side, covered with dry dressing gauze or other ointments currently used for local burn treatment (silver sulphadiazine or povidone iodine), was used as the control side. A strip of healthy skin at least 2 cm wide separated the wounds from each other. The total burn surface area (did not exceed 15% TBSA in order to avoid any systemic effect due to the burn injury.

After application of the ointment to be tested, the wounds were covered with sterile gauze fixed with staples. The dressings were changed every day, while assessment and documentation were performed on days 2, 4, 6, and 8.

Results

A. Extent

Computerized planimetry based on colour changes in the surface was selected as the most accurate method for assessing the surface of the wound (Fig. 3).

The method is applicable exclusively on full-thickness wounds and not on those of partial thickness, since the epithelialization is spontaneous, deriving from different parts of the wound, and thus does not form a unified colour area.

B. Physical examination

A close-up picture of the wound was taken every second day and clinically evaluated in order to document the oedema, necrosis, and exudation of the wound. The MEBO-treated wounds showed accelerated epithelial repair in superficial, moderate, and deep partial-thickness burns. None of the wounds, regardless of depth, became infected (Fig. 4).

The quality of the eschars appeared to vary in relation to the substance applied. The eschars formed by MEBO and silver sulphadiazine ointment were softer and easily rubbed off in small pieces on consecutive days. The absence of the eschar, even partial, facilitated a more accurate observation and assessment of epithelial repair. The quality of the eschar also reflected the regeneration of the new epithelium, which remained intact and presented even macroscopically a better architecture, leading to a better quality of scar formation (Fig. 4). The rapid cleansing of the burn wound, combined with the rapid onset of epithelialization, led to the clinical impression that MEBO had a debriding effect.

The eschars formed by povidone iodine ointment had the same quality as those of the control group. The eschars were hard and solid; they were peeled rather than removed in one piece on one day, thus hindering epithelialization.

C. Transepidermal water loss
The measurement of transepidermal water loss (TEWL) is an important non-invasive method for assessing the efficacy of skin integrity as a protective barrier (Fig. 5).

Fig. 5 - TEWL is an important non-invasive method for assessing the efficiency of the skin as a protective barrier.

The stratum corneum forms a barrier against diffusion of water through the epidermis. As a consequence, the measurement of TEWL provides information concerning the integrity of the epidermis.

For this purpose the Dermal-ab system equipped with a TEWL probe was used. This is based on the vapour pressure gradient estimation method of Nilsson.

Immediately after the burn injury, TEWL - as expected - showed its highest value, which was related to wound depth. Water loss diminished progressively as the epithelium covered the wound surface.

Superficial burns treated with MEBO presented on day 7 post-burn a water loss of 15.2-34.4 g/M2/h, compared with 29.8-79.7 g/m2/h in the control group and 21-84 g/M2/h in the conventional agent group (povidone iodine or silver sulphadiazine ointment) (Fig. 6).

Fig. 6 - Evolution using MEBO ointment. Superficial partial-thickness burn. Appearance on day 7 post-burn.

Moderate burns treated with MEBO presented on day 7 post-burn a water loss of 17.9-34.4 g/M2/h, compared with 28.338.8 g/M2/h in the control group and 17.447.6 g/m2/h in the conventional agent group (Fig. 7).

Fig. 7 - Evolution using MEBO ointment. Moderate partial-thickness burn. Appearance on day 7 post-burn.
Deep burns treated with MEBO presented on day 7 post-burn a water loss of 18.0-27.6 g/m²/h, compared with 30-43 g/m²/h in the control group and with 27.346.9 g/m²/h in the conventional agent group. This is an objective indication of the accelerated epithelialization due to the effect of MEBO.

D. Moisture
All the burn wounds showed high moisture values, which reached their peak on day 2 post-burn. Wounds treated with MEBO showed high moisture values until day 4 post-burn. These values were higher than those found in burns treated with silver sulphadiazine ointment, which also presented moderate moisture values. In contrast, wounds treated with povidone iodine ointment, as also burns in the control group, showed low moisture values as early as day 2 post-burn. The moisture values in all groups fell to almost zero on days 4-7 post-burn.

E. Histological specimen
The depth of the wounds, as also the control of epithelialization, was confirmed histologically.

Conclusions

1. TEWL is an objective non-invasive method of measuring wound healing and assessing epithelial repair.
2. There is no relation between pH and wound healing.
3. Measurement of moisture in the wound may give additional information regarding the wound healing process. MEBO manifests a moisturizing environment for a longer period than other substances.
4. Planimetry is an efficient method for the estimation of the wound surface area and the progress of healing in full-thickness burns only.
5. MEBO significantly accelerates the wound healing process in partial-thickness burns, as observed by TEWL and the wounds' clinical behaviour.
6. MEBO contributes to a better quality scar after epithelial repair than other local agents.
7. Local substances applied to burn wounds may provoke a debridng effect. In a moisturized environment where eschars are easy to remove in small pieces MEBO showed an efficient debridng effect compared with the other agents.

BIBLIOGRAPHY

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