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An amphoteric rinse used in the emergency treatment of a serious ocular burn

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1. Introduction

Serious eyes burns represent extreme problems in the treatment and rehabilitation of victims. Although progress has been made in the general understanding of eye burns [1], the inflammatory response to eye injury [2], electrolyte shifts [3], understanding neurobiological mechanisms [4] and major improvements in treatment by the use of limbal grafts [5], the best treatment of eye burns is to avoid progression of the damage. Experimental research has shown the correlation between the concentration, time and the type of chemical exposure, and the clinical prognosis, in relation to parameters such as rate of change in intraocular pH [6–12]. This gives a rough estimate of the seriousness of the burn. In contrast to these results clinical experience shows that delay in treatment of eye burns carries serious prognostic implications. This report is part of our prospective study in Martinique [13] that shows that in the eyes burnt with ammonia (Alcali®: ammonia 15.3%, pH: 12.8) a delay of more than 30 min before treatment will result in a serious eye burn. Early rinsing is essential to limit to a considerable extent the severity of eye burns.

The development of a new external rinsing solution using an amphoteric agent such as Diphoterine® which can capture both base and acid in contrast to conventional buffers or electrolytic solutions, has potential to improve the clinical outcombe of eye burns. Diphoterine® has been shown to be effective in vitro and in vivo experiments [10–12] and in occupational medicine [13], where the time to rinsing was shorter than 10 min. Nevertheless, our own experimental work has presented histological evidence of the reduction of corneal edema even after a delayed rinsing with Diphoterine® up to 30 min following the accident [10]. This corneal stromal edema is highly correlated with the development of corneal scars [14]. In this to report we present a case of serious eye burns (grade IV of Ropper Hall's classification) healed by a simple conservative therapeutic regimen, preceded by an initial rinsing with 1 l of Diphoterine®, 1 h after the accident.

2. Case report

A 49-year-old woman, social assistant, was attacked with a chemical product which was thrown onto her face and eyes on 19 August 1999. She was driven to the Ophthalmological Service. The immediate eye examination showed a serious burn to the right eye. The visual acuity was 2/20, the cornea was opaque. As a consequence, the iris was hardly distinguishable. The limbus showed a conjuctival and limbal ischemia throughout 360°, with scleral necrosis on the infero-nasal region. The corneal epithelium was completely removed. An immediate eye rinse was started 1 h after the accident. One liter of Diphoterine® was used. The rinsing was enhanced by instillation of local anaesthesia with oxybuprocaïne eye drops. Further treatment consisted of instillation of two drops of a combination of dexamethasone and neomycin. An immediate anterior chamber puncture was made following the rinse and the lacrymal duct was cleaned by a direct rinsing. The eye was examined a second time. An eye burn grade IV of Roper Hall's classification was confirmed (Figs. 1 and 2). A slight decrease of the corneal edema

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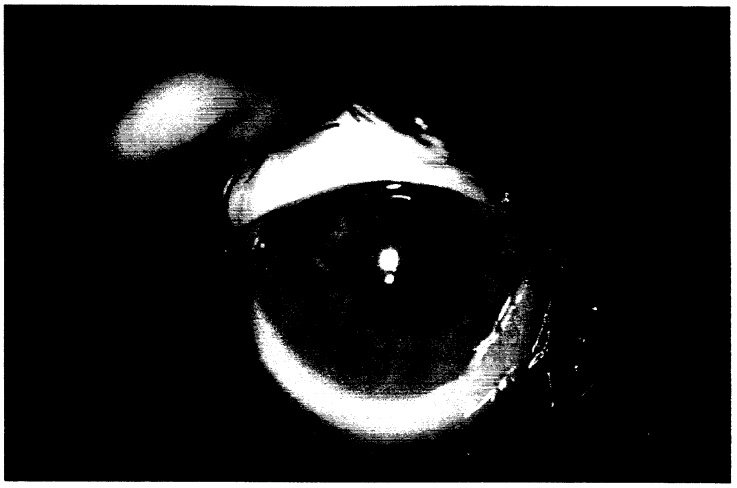

Fig. 1. Initial examination of the right eye after the rinsing by Diphoterine® (1 h after accident): importance of stromal oedema.

was noticed. The visual acuity was then 0.3. We continued with dexamethasone–neomycin eye drops every 20 min during 3 h more. The subsequent therapy regimen consisted of dexamethasone–neomycin eye drops, indomethacin 0.01%, rifamycin, gentamycin and ascorbate eye drops six times per day. This medication was complemented with high doses of oral ascorbate (3 g per day). To obtain cycloplegia, we administered atropine 1%, two drops a day. An antisymblepharon ring was placed immediately. Progression to healing with a progressive re-epithelialization took place within 21 days. The corneal surface was irregular and showed a punctuate keratopathy pattern. An infero-nasal stromal edema persisted. The visual acuity obtained was 4/20. We stopped the local antibiotic and removed the antisymblepharon ring. Tear substitutes with carbomere and vitamin A ointment and drops were used. On day 35, we noticed a corneal infero-nasal ulcer. The local corticosteroid was stopped and antibiotic treatment with rifamycin restarted. After this 5% acetyl cysteine eye drops were used. The ulcer increased its size and the stroma edema enlarged. New vessels appeared on this site. At this point, local corticosteroid administration was started again using fluorometholone six times a day. On day 42, we noticed a decrease of the stromal edema and ulcer size. On day 56, the rifamycin eye drops were stopped when an orange impregnation of the corneal stroma was seen. Tobramycin was substituted in place of the rifamycin. Vitamin C eye drops were stopped when the patient complained about pain due to there use. The cornea was fluorescein stain

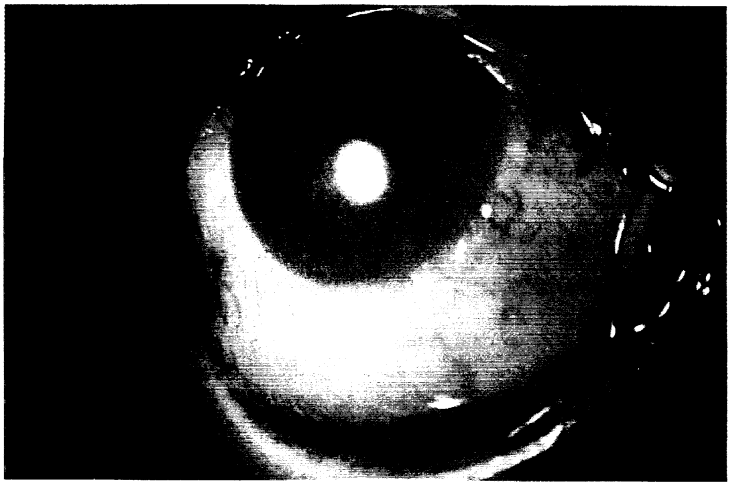

Fig. 2. Initial examination of the right eye after the rinsing by Diphoterine® (1 h after accident): conjunctival and limbal ischemia 360°; scleral necrosis on the infero-nasal region.

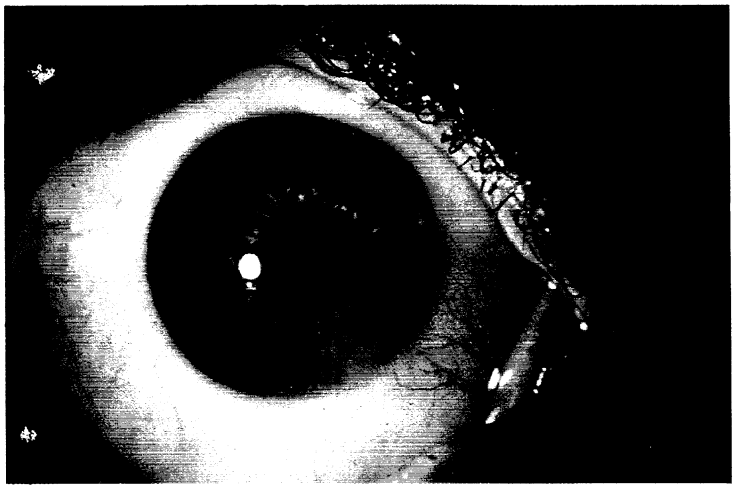

Fig. 3. Final examination of the right eye: total re-epithelialization of the cornea; stable neovascularization in the infero-nasal region; visual acuity: 14/20.

negative and non-edematous since day 97. The visual acuity obtained was 20/40. Topical corticoids were discontinued and local tear substitutes and vitamin A oinment were prescribed. In the infero-nasal region, the neovascularisation was replaced by a conjunctivalization which progressed to day 180, and is now stable (Fig. 3). The visual acuity is currently 14/20. The other eye had a less serious burns with a punctuate keratopathy within the interpalpebral region.

3. Discussion

This report presents a clinical case of a serious chemical ocular burn which healed with conservative treatment. Among the numerous factors involved in this healing, its seems important for us to underline the initial ocular external rinsing with Diphoterine®. In fact, it is quite unusual for such serious burns to heal, and in extremely serious cases, the healing is generally associated with sequelae. The treatment may involve several surgical procedures. The relevance of the rinsing with Diphoterine® was proved by in vitro and in vivo experiments [10–12], which showed a return to a physiological pH a few minutes after its use. Clinical human data [13] obtained on workers in the chemical industry also showed the relevance of ocular rinsing in the first minutes following the chemical splashes: the losses of days of work is diminished thanks to use of Diphoterine® [13].

Diphoterine® is an amphoteric solution, hypertonic to the anterior chamber of the eye. An amphoteric molecule is a molecule which is able to bind a base as well as an acid. So, Diphoterine® can bind both acids and bases and, thanks to its hypertonicity, it can create a flow of water from the hypotonic anterior chamber to the external surface of the hypertonic cornea. This flow of liquid induces the outflow of the H^+ and OH^- ions. The, Diphoterine® will bind H^+ and OH^- ions. This is a very simple approach to the mechanism explaining the efficacy of Diphoterine®. Other mechanisms, which will be evaluated in further experiments, seem to play a role to explain especially its capacity to remove H^+ and OH^- ions from the anterior chamber. But from an experimental point of view, the return to a physiological pH, proof of the ocular extraction of the chemical product, occurs only if the rinsing is made in the first minutes following the chemical splash. Our experimental study showed interesting anatomopathological results [10]. So, the presence of a stromal oedema in the experiments without rinsing or with a rinsing by a 0.9% saline solution is quite remarkable as no edema was observed after rinsing with Diphoterine®. We can note that for our patient, the corneal oedema decreased after rinsing with Diphotérine®. Stromal oedema is a negative factor as Kubota and Fagerholm [14] showed that the degree of this initial oedema is correlated with intensity of the resultant leucoma, responsible for the decrease of the visual acuity. These authors explain that the stromal blank thus created by the odema will be colonized by keratinocytes. These cells will then form an anarchic net of collagen fibers which are responsible for the decrease of the transparency of the cornea.

After the decrease of the amount of the chemical product in the eye, the second important factor in the treatment of a chemical burn is the fight against stromal invasion by inflammatory cells. Stromal invasion by polymorphonuclear cells (neutrophils) was observed experimentally 2 h after the chemical splash. Two peaks of invasion were seen: the first peak occurred after 12–24 h, while a second peak occurred around day 21 with a beginning on day 12 [15]. For this reason strong doses of dexamethasone were given topically to continue to counteract the stromal oedema. The use of topical corticoids on an ulcer was discussed as they could slow down the wound healing. But experimental studies

[16] and then clinical studies [17] demonstrated the lack of deleterious effects in this pathology. Finally, it is necessary to give to the cornea the possibility to heal. This healing progresses through re-epithelialization of the cornea, as shown in our case report. Two factors are fundamental in this re-epithelialization: a good quality of stroma to act as a framework and a proliferative capacity in the epithelium. The first point is fundamental, so it is necessary to counteract stromal oedema, which is why corticoids are relevant, even if used at a certain time after from the burn, as shown in our case. It is also necessary to give strong doses of vitamin C because of its assisting role in collagen synthesis [18–20]. The other factors involve the limbal stem cells and a particularly important influences is the density of the stem cells found in each unit of the corneal circumference. The recurrent inferior nasal ulcer seen in our case can be explained by the fact that the burn, more serious on this level, induced necrosis of the large part of these limbal stem cells. Wound healing in this area will involve only a moderate conjunctivalization. It is also necessary to help this epithelialization providing lachrymal substitutes (the victim of this type of burn develops a lachrymal deficiency) and vitamin A eye lotion. Finally, our case report demonstrates the interest of placing anti-symblepharon rings to prevent or decrease the importance of the symblepharon which usually happens after such a serious burn.

4. Conclusion

Our clinical case demonstrates that a well-conducted therapeutical protocol can sometimes heal a serious ocular chemical burn. Nevertheless, the prognosis for such burns remains dependent on the delay before intervention and more particularly on the rapidity and efficiencies of the external ocular rinse. Among the different rinsing solutions available, Diphoterine® seems to be valuable even after a longer delay of more than 10 min.

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