Acute Therapy for Chemical or Thermal Eye Irritations

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Introduction

The chemical burns of the eye is today as in the past a wide spread phenomena in the scope of work. A fluctuation case predominates these days about the therapy that should be followed in work sites (factories and workshops) after publication of some cases of cornea calcification under the effect of phosphate buffer (16) and entering new therapeutic solutions in German market. According to clinical experience for various years in the Ophthalmology dept. in Aachen University hospital in the scope of chemical burns of severe grade and according to the results of the works and reports of Reim (15) and Kuckelkorn (8) to identify the prognosis factors in chemical eye burns, it resulted that the time of starting with therapeutic rinsing of the eye is the most important factor in identification of the results of the accident (table 1). Therefore, we offer the mechanism of chemical eye burn, in addition to the results of our experiments and studies and our trying to give advice for the primary therapeutic treatment.

the accident mechanism of chemical burn

the burns areas

the burn lead to a local destruction, lesion in the tissue and necrosis. The prognosis of the eye identifies with the tissues that will be safe from injury in addition to the partially infected tissues. There is the lower grade, grade I and Grade II of burns which is healed continuously and whose case are not related to the applied treatment. The other injury cases are irreversible injuries in spite of the application of ideal treatment, and the prognosis and progress of the disease is very difficult. according to our experience, the kind of treatment and thus the time of starting interference and thus the therapeutic interference, the biggest factor in expansion and severity of injured parts, but regretfully, we meet burns cases that is extremely big according which the optimum treatment is able to prevent the lost of the eye but it doesn't give the possibility of healing. the target of all our researches is the best treatment of the medium grade burn cases and developing an optimum concepts of treatment which in turn enables the treatment of severe burn cases.

Evolution of scientific research about the chemical eye burns

The evolution of therapeutic concepts and hazards paces statically and expressly forward especially after the evolution of Ex-vivo systems which assists in turn to explain the burn mechanism, especially the scientific works about the different surprising chemical materials, especially those made by Maurer (11) that we would like to refer. Currently, the experiences advance about the mechanism of chemical burns according to the paid efforts by manufacturers and the researches applied on the animals. The advice about the primary treatment of chemical eye burns by the usage of tap Water, sterile physiological saline, phosphate buffer used since 1953 (2). These instructions had been effected concerning the method of application, the used preservative materials, sterilization and training about the emergency interference of usage but no new therapeutic concepts had been evoluted.

Currently there are new treatments for burns which no bargain about (17) as it had been described in the last years precisely (4,5,7,9,18). For the first time a comparative study appeared about the chemical eye burns by Martinique (3). In the same time, the authors issue themselves about excellent clinical therapeutic treatments of severe burn cases after treatment with Diphoterine (= the international name of Previn) (4).

in order to understand the direction of the scientific research about the burns, we mention out of them in Ophthalmology, eyes burns was considered an example of severe chronic inflammation. According to this model, the prognosis factors, the treatment factors of keratitis and burn diseases had been studied. According to old studies it was believed that the instant treatment with phosphate buffer at rate of pH=7.4 could regain the intraocular pH value after the chemical burn to its optimum value. and accordingly it wasn't followed with scientific researches in this field. The known experiences that the buffer capacity of phosphates in the alkali scope is weak and it is equated with special cases of eye rinse with athenic acid.

In the scope of the basic rules of scientific research, it is known in the preventive medicine, Medicine of profession that upon scientific research the chemical eye burns, the priority returns to the chronic inflammation cases. in all cases, there are little experiments that had been evoluted about hydrofluoric acid (12,13), because the phosphate buffer in this case doesn't show any therapeutic effect, therefore, our aim is to submit new data for the scientific research about the chemical eye burns, therefore we effect the therapeutic instructions of the last ten years.

The mechanisms of eye burns

Throughout the kinetic capacity of the eye, the chemical materials penetrates the tissue and structure of the eye severely. This hazard appears evident throughout the exploded automobile batteries that holds components with sharp ended with the sulphuric acid, moreover the liquid mettalling gun and concrete (beton) from beton pumps holds a huge kinetic capacity that causes in turn severe eye injuries (Form 1, 2). finally appears the thermal effect that starts with heat increase and ends with coagulation with necrosis of eye components in case of liquid metals.

In most of these cases, the reaction starts in all cases through the osmolarity and pH and the oxidation action with the action of the Reduction of the burning material which reacts with the reaction of the eye components.

The precautional procedures are protection glasses or instruction boards that protects man and eye. in case of an accident, they eye must be rinsed to cool it firstly and to return the physical and chemical components of ocular components and minimizing the severe inflammatory case secondly.

The therapeutical rinsing for cooling

to suppress the exothermic chemical reactions in a mechanism whose biological action considers cooling as a valuable therapeutic procedure. The activity of rinsing for the target of cooling enables us to show on 11 safe human samples. We rinsed eyes with a quantity of 500 ml at 4 centigrade of Ringer lactate for a period of one minute and in parallel images had been taken via Jeol Infrarot-Camera for parts of the face with the rinsed eye. confirm the temperature of Apex cornea via the thermal images corresponding to the times shown in (Form 3) in a graphic form then the images to be taken immediately before and after drying after rinsing (Form 4) and later on till after 8 minutes after rinsing

Therapeutic rinsing to normalisation its pH

making buffer without insoluble saline precipitation

it is valuable to raise the degree of solubility resulted from burns in order to preserve the resulted materials at reaction with the same weight and due to infinity of chemical reactions in tissues depending on quantity, the tissues mustn't be destructed from the outcome of the chemical reaction. This is the accident that happened for Protein through its urgent loss of its function then its destruction. Throughout buffer, this reaction could be displaced towards salinity forming buffer and

according to special reaction and the degree of salt solubility. this means for example that its is formed in the case of phosphate buffer with calcium ionic insolvable calcium phosphates throughout the ions of calcium available physiologically in the tissues or with the exogenous calcium ions in case of burns with lime. thus calcium responds in case of burn with lime and after rinsing with phosphate buffer. so the dangerous Hydroxide ionic OH^- is equated with the insolvable precipitation of calcium salts (16).

In order to stop this reaction for suppressing the chemical reaction non wished for in the tissues taking care for the insolvable products and taking care of the law of mass work mechanism, there are two probabilities, Joining the chemical irritating material, therefore the ionic active particle activity ready for reaction minimizes and from other hand we preserve the products of reaction in its liquid form. This is one of the parts distinguishing the hot physiological mechanism of the body throughout Ascorbat and Glutathion available in the cornea. it could minimize the concentration of the materials resulted from the reaction.

This is what we can do through dilution and chelat bond, joining the targeting chelat or aiming at joining chelat . The capacity of ligandbond may be much bigger than the solution capacity that an erosive (to corrode) materials such as positive double charge ions of some materials such as EDTA are received completely practically. with similar Mechanical work Mechanism that could be found for Hydroxyl ionic, that the manufacturer of Previn in hydroxyl ionic available in the Previn solution and Diphoterine Including toxin extract materials.

this chelat bond extracts (separates) OH- or H+ from the solution when measuring the pH value according to the Neutralisationreaction by decrease of H+ or OH- ionic and thus a displacement of the pH value is resulted towards the point of neutral.

the experiments made in Becker for the various eye rinsing solutions used clinically

we detected some various current solutions according to experiments in Becker (in vitro)

(form 7-8). a quantity of 5 ml of 0.5 mol of caustic soda lye and hydrochloric acid in the pot at room temperature of 20 degrees separately. these two pots had been titrated through an experiment in vitro under measurement of continuous pH via (Radiometer pH-meter 240).

the following materials had been checked : Ringer lactate (Fresenius), Nacl 0.9% Isotonic physiological saline solution (Braun), (PBS)= phosphate buffer (=Isogutt), Previn solution (Prevor). tap water from the water of Aachen University Hospital. The experiment had been prepared for (4) times and inscribed in the report of experience by TÜV-Rheinland for detection of productions and their safety. The results of this detection are inscribed in form

(7 and 8). For Nacl and tap water only their dilutions curves are available, while Ringer-lactate and phosphate buffer have similar congruent titration curves in the scope of alkali, good buffer properties for phosphates in the scope of acid titration, for Previn a high buffer capacity in the scope of acid and alkali together.

Eye burns and intraocular-pH

The electrolytic dissosiation of the burning materials and the products resulted from their reaction with the ocular tissues lead to changes in intraocular-pH that could be measured.

The activity of chemical burning material in the Ophthalmology depends on the rate of pH-value not on the denaturation process resulted from the reaction of Peroxide or the Radical which facilitates of course the value of measuring pH. In order to be able of measuring intraocular-pH we enucleated the pig eyes newly slaughtered in the slaughter house in our experiments and preserved it at 4 centigrade. we made a tension of the eye by pricking it into the optic nerve with infusioncanal connected with infusion set at height of 20 cm. Including a solution of Nacl 0.9%. the anterior chamber was opened via

1.7 mm paracentesis at limbus then throughout the opening a micro-pH-electrode had been put. The calibration of this electrode through 3 buffer solutions at pH-Meter Radiometer 240, the evaluation of the results made by the usage of UNI-MESS program. after burning the eye for 20 seconds with 50 µl of 2 mol caustic soda lye, the rinsing of the corneas had been begon with various duration (20-40-60-80) seconds with various solutions: tap water, saline 0.9% and Ringer-lactate, phosphate buffer, Previn and for various periods 500-1000 seconds. these experiments are described in form (5) and form (6) in addition to forms (9-13).

The mechanical changes of pH

To normalise the pH value through the organic and inorganic buffer of the tissues through bond salts resulted from the buffer materials or through the separation of OH- and Na+ ionic.

This is what we were able to display on animals via phosphate buffer and Diphoterine (16). here it is not required to separate the ionic through buffer in necessity while this is possible through Amphotere too. These materials can neutralise of acids and bases at one time.

the H+ and OH- ionic may be chelated (the entry into a reaction with the chelat) through the stable bond materials and high activity complexed therefore withdrawing them into an other chemical reactions. as the manufacturer of Previn shows an activity of titrationsexperiments and the clinical experiments in forms (7, 8, 13).

osmolarity

the osmolarity is identified with the result of all soluble ionic and the activity of the mono activity particles with the reaction partner in tissues. The change of osmolarity leads in the semi-permeable cell membrane to water movement. and this in turn leads to shrinking or swelling of cells.These two accidents lead to severe injury of the cellular membrane and intra cell so in the case of hypoosmolarity the cellular membrane may be exploded, and in case of great saline concentration, the proteins may lose its function through water drawing mechanism.

the osmolarity of cornea tissues after burning changes. We had measured the values till 1280 mOsmol/kg. the natural cornea osmolarity reaches about 380-420 mOsmol/kg as the burn leads to the multiplication of the ionic activity to three times. the change of severe osmolarity to the zero through water rinsing leads to cytolyse therefore to aggravating and increase of injury as we were able to a short assessment and the confirmation of used solution osmolarity in rinsing affects the osmolarity of the cornea and in direct when rinsing for 15 minutes (7) .

in experiments of the cellular breeding (muriner L 929) Fibroblast in14 to19 passage and under the standard cellular solution these effects appear and could see the explosion of cells under injury with osmotrauma (Form 14 a, b). The gradual decreasing of osmolarity to the natural level must be the first target of the therapeutic solution. the most important is that the transport of water from the cells must be active process from the cells and in analogy the rash flow of water because of the decrease of osmolarity of peripheral media of the cell must be passive process (form 15). Accordingly it could understand that the rash decrease of osmolarity through tap water or destillited water leads to severe osmolar injury, consequently the death of cells though the tissues are still partially alive.

Discussion

The question about the used solution that minimizes the accident injury remains without reply now. There is only one clinical prospective double blind study now concerned in this subject, here is J.D. Herr et al. (5) it decided about balanced salt solution (BSS) in comparison with the bicarbonate

solution and the physiological saline solution and Ringer solution in the primary treatment as it is depended on the acceptance of the rinsing solution not on the results of clinical healing results, here the BSS appeared as the best rinsing solution.
There is no prospective study for the patients of burns comparing the water or physiological saline solution or the phosphate buffer or Diphoterine. The Diphoterine had been tested versus phosphate buffer on safe samples in a positive form and positive results (7), our group issued the safety of tests in an experiment on animals (19). In the scope of clinical therapy, it was spoken positively always about Diphoterine and in a control case studies (4).

there is no comparative experiments on animals which tests the activity of one of the used materials in rinsing that decides evidently that this material leads to healing or that the other material doesn't lead to healing. the experiments presented by us in The forms (9-13) aim at making such comparative studies on animals. This what could happen in case of finding stable limits allows to assess and identify each of these materials. Then it could speak about the evident marks of an experiment on animals. Here is the same question is asked, as it is the ethnic deontology then the presented results is out of the experiments on the slaughtered animal eyes in the slaughter house and the best results could attain from the experiment on the alive animals with the comparison of various solutions. This experiment depends basically on the material causing burn. Therefore we make our experiments now with the acids and radical burns and the method of treatment with the solutions used in rinsing.

According to the basics of medicine the control studies is considered not sufficient. Here a report had been issued about ionic sorption in 1990 (6). here we could refer that a prospective study goes in parallel about Diphoterine (3). Each of water or saline physiological solution hadn't been studied and checking its therapeutic effect in treatment of burns through researches experimentally until now. There are no clinical studies until now about the phosphate buffer or the Diphoterine versus water. The results presented by Laux that speaks about the values of pH better for the anterior chamber and under the effect of rinsing with phosphates in addition to our completely indefinite results, is considered until now the only reliable origin of information. The recommendation presented by employer's lability insurance association for the necessity of rinsing with water after ocular burns by adoption on actual case and in case of an accident emergency in a location that is not provided with emergent pharmacy is considered correct and acceptable as in the past, but it is doubtable in case of an accident in the place of work in which any of the optimal and previously tested solutions have to be available. It seems that these recommendation depends on the availability of water in each place, but this hadn't been applied on animals. Our results shows in all cases evidently an active effect in the action of ionic equation H+ and OH- with the equation of Intraocular-pH for Previn (Diphoterine) (form 7,8,13) followed by phosphate buffer (form 7,8,11) followed by Ringer-lactate (form 7,8,10) by depending on pH the anterior chamber.
This depends and resulted from the high activity and the big capacity of buffer for Previn versus other tested materials. Our measurements of pH values, osmolarity and the ionic contents makes us suppose that the principles of primary therapy of the chemical burns of the eye could be improved optimally (form 14,15,10,18,19). Till now it is not possible to made double blind study according to the conditions of Food & Drug Administration for emergent burn cases of the patients or the experiments on animals in order to specify one of the products as a primary therapy for burns. The experiments on animals are at minimum rates considered a motive for the burns with caustic soda lye and the treatment with phosphate buffer and Diphoterine.

A view towards the future

The Aachen Center of Technology Transfer in Ophthalmology **ACTO** searches now in cooperation with Ophthalmology Dept. in Aachen University Hospital intensively the mechanism and new therapeutic concepts for the chemical eye burns. It is possible to make a prospective study for the emergent treatment of rinsing the eye experimentally on animals, in the scope of work field which is exposed to a big number of infected persons with burns. Making this experiments is met with the instructions of Employer's Lability Insurance Association and its recommendations in the primary treatment of the chemical eye burns. These recommendations from our point of view and according to our satisfaction, couldn't be scientifically confirmed.

Recommendations

Generally we recommend in case of burns with the primary treatment with one of the high capacity neutralisation solutions, for example Diphoterine, Previn and Borat-buffer (Cederroth solution) too in case of alkali burns. In case of burning with lime, it shouldn't apply Phosphate buffer and each burn case should be tested and treated by a specialist physician.

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Forms

Form 1

shows severe injury resulted from concrete through explosive concrete source. the remains of the materials causing burn appears in fornix and in the conjunctiva.

Form 2

the separation of the active chemical residues of concrete pH=9 via Hockey-knife and under rinsing with sterilized Ringer lactate solution.

Form 3

Infrared thermographic for measurement of the temperature of the central surface cornea after elapse of one minute after rinsing of 11 eye samples at 4 centigrade of sterilized Ringer lactate. The rinsed eyes (lower line) shows evidently the decrease of temperature.

form 4

infrared thermographie of the left eye directly after rinsing with the cold Ringer lactate solution at 4 centigrade. The dark surfaces shows the action of cooling on both eye and skin.

Form 5

Intraocular-pH changes of the enucleated pig eye by measuring the pH in the anterior chamber after application of filter paper absorbed with 50 µl of 2 mol caustic soda lye solution on the cornea which shows us the effect. After elapse of 110 seconds, the value of pH arises. we explain this time, as it is the necessary time of the Hydroxyl ionic available in the eye. during this time, the cornea is subsequently destructed from external part towards internal part, with the increase of pH value of the anterior chamber as the destruction of the eye parts is increased.

Form 6

the changes of pH value in the anterior parts of the eye after burning with the battery acid
50 µl of H_2SO_4 37% for 20 seconds. the penetration could be shown to the inner part of the eye after elapse of 80 seconds through the fall of pH.

Form 7

the titration curves of caustic soda lye base with the used solutions in rinsing eye (the neutralization of acids with buffer is made better than bases according to Thiel 1956). the phosphate buffer pH=7.4 is not acidic controlled well, to reach the case of neutralisation, Previn neutralises the bases more faster than other materials.

Form 8

acid titration curves with the used solutions in rinsing the eye. Here the phosphate buffer affects (buffer action), (the triangles).The Previn affects less than 8 times that means in evident form earlier the action of pH-neutralisation.

Form 9

therapeutic rinsing with NaCl 0.9% after chemical burn with caustic soda lye with 50 µl of
2 mol NaOH for 20 seconds. The first of treatment by rinsing after 40 seconds (in the left) and after 80 seconds (right curve). the measurements of intraocular-pH appears after treatment with NaCl 0.9% the arise of the pH could be limited (identified) by continuous treatment at pH=10.

form 10

rinsing treatment with tap water for a chemical burn with caustic soda lye of 50 µl 2 mol NaOH for 20 seconds on the enucleated pig eyes. The beginning of treatment with rinsing after 40 seconds (the light curve) and the grey curve after 60 seconds, and the black curve after 80 seconds of the beginning of the burn. after this the intraocular-pH had been measured and under treatment with tap water, the value of pH is resisted with continuous rinsing of water with the time intervals 20, 40, 60 seconds and in a worse form at the value of pH=11.

form 11

rinsing treatment with Ringer lactate after chemical burn with caustic soda lye for a quantity of 50 µl 2 mol NaOH for 20 seconds. then the measurement of Intraocular–pH continuously. The beginning of therapeutical rinsing is effected with intervals of 20, 40, 60, 80 seconds after burn. Under the therapeutical effect with Ringer lactate, the pH could be stopped well when starting rinsing after elapse of 20 seconds. when delayed for 40 seconds, either neutralisation is effected or it happens as in the beginning of rinsing after elapse of 80 seconds of the increase of intraocular-pH severely.

form 12

the therapeutical rinsing with phosphate buffer after chemical burn with caustic soda lye a quantity of 50 µl and 2 mol of NaOH for 20 seconds followed with measurement of intraocular–pH and under treatment with phosphate buffer with delay of starting rinsing 40, 60, 80 seconds, the increase of pH well will be stopped with continuous rinsing in the case of 40 seconds. in case of delay for a longer period the intraocular-pH is severely increased.

Form 13

the therapeutical rinsing with Previn of a chemical burn with caustic soda lye with a quantity of 50 µl and 2 mol of NaOH for 20 seconds. the intraocular-pH could be measured under the effect of Previn. the increase of pH could be blocked during the early and delayed time intervals together.

form 14a
shows cells in the cellular area before rinsing with tap water.
form b shows case of cells in lyse under the effect of hypoosmolarity.

Form 15
the difference of osmolarity between the safe cornea (of the left) and the Material causing burn from 1 mol of caustic soda lye base in the right (7).

The table 1
the importance of the primary treatment of the therapeutic progress and prognosis of the disease (n= 107 patient, 131 thermal burn case or severe chemical burn of the eye) (8, 9).

Number of operations,
period of residency in the hospital (healing period in months),
The case of immediate rinsing ,
non rinsing or delayed rinsing .

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