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Original Article

Effect of Sodium Lauryl Sulfate (SLS) on the External Adnexia of the Rabbit Eye

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Abstract

Sodium Lauryl Sulfate (SLS) is an anionic surfactant used in the production of personal hygiene products such as tooth pastes, soaps, shampoos, shaving foam and other consumable related products. This study evaluated the effect of SLS on the tissues of the external adnexia of rabbit eye Varying doses of SLS (5mg/ml and 10mg/ml) was instilled on the eyes of New Zealand rabbits and the ocular status was observed for five days using a 20X magnification lens. It was observed that SLS was toxic to the external adnexia of the eye and caused some morphological changes. There was swelling of the eyelid, hyperemia in conjunctiva, tearing, discharge, photophobia and edema which were visible from up to day five with optimal changes on day three. The effect was dose dependent and more significant in animals instilled with 10mg/ml of SLS solution. The results suggest that SLS was toxic to the rabbit eye and increased dose could increase toxic effect on the eye. This study has exposed the effect of SLS to the eye and recommends minimal concentration in cosmetics and household hygienic detergents that can get direct contact with the eye.

1. Introduction

Sodium lauryl sulphate (SLS) is an anionic surfactant which is capable of foaming and making bubbles in water[1]. This property makes it a very good chemical for detergents commonly used in the production of personal hygiene products such as tooth pastes, soaps, shampoos, shaving foam, body washes and cleansers, make-up foundations, liquid hand soaps, laundry detergents and bath oils/bath salts, hair color, bleaching agents and others[2]. It is found in about 90% of these products and widely used on daily basis for cleaning the body [3].

Although it originates from coconuts, a natural source, the real problem with SLES (Sodium Laureth Sulphate) /SLS is that the manufacturing process (ethoxylation) results in SLES /SLS being contaminated with 1,4 dioxane, a carcinogenic by-product[4], making it a toxic substance. A solution of just 2% SLS can increase skin thickness, cause irritation, inflammation [5] and increase other forms of immune activity in the skin[6]. SLS can cause an increase in enzyme levels in the skin, leading to redness and swelling [7]. It can also lead to dryness, roughness and even flaking of the skin. SLS can damage the delicate mucosal membranes in the mouth, causing the separation of epithelial layers from the mucosa and the tissue damage caused by SLS increases with increasing concentration of SLS[8]. Mouth ulcer has also been observed with the use of SLS [9, 10].

Certain studies have shown SLS to have toxic effect on the eye. SLS can penetrate the cornea of the eye (even if absorbed through the skin), accumulate readily and is released slowly. These effects are greater in younger individuals [11, 12]. Also, it has been shown that solution of 1.3% SLS can reduce the rate of healing in the eye [13].

However, though these studies showed toxic effect on the eye little is known on the dose dependence of the effect and various morphological changes on the external adnexia. Hence, this study investigated the effect of SLS on the tissues of the external adnexia of the eye and the ocular response to varying doses of SLS.

2. Experimental

2.1 Drugs and reagent

Vitalyte; Embazin; Keptomec (invermeetin) by Kepro B.V., Meagolenburstract, Holland; lidocaine injection B.P 2% by Sai Parentarels India; sterilized water for injection by pyrogen free, Infusion Kenya Ltd; Sodium Lauryl Sulfate by Aldrich Chemical Company, Inc. USA; Bio Glo fluorescein sodium ophthalmic strips by Contacare opthalmia and diagnostics, India; Normal saline.

2.2 Animals

Healthy New Zealand rabbits (2.5 ± 0.5kg) of the same colony and both sexes were purchased from the Animal Centre of Ambrose Ali University, Ekpoma, Edo State, Nigeria. These animals were kept under standard laboratory conditions (12 hours of light and dark cycle). They were fed with standard pelletized chow (Bendel Feeds Plc., Ewu, Edo state, Nigeria) and water *ad libitum*. The animals were handled according to stipulated guidelines for the use of laboratory animals as enshrined by the University of Benin Animal Care and Use Committee with reference to the United State of America Animal Welfare Act[14].

2.3 Study design

The animals were acclimatize for three weeks and were distributed to 3 treatments groups of 4 animals each and the treatment was instilled into rabbit's eye for five days. Group A rabbits (the control group) were instilled normal saline, group B rabbit were instilled 5mg/ml solution of SLS into the eyes and group C rabbits were instilled 10mg/ml solution of SLS into their eyes. The solutions of SLS in the experimental groups (B and C) were instilled as stipulated by Millipore[15].

Before treatment administration, the animal's eye was examined. The external adnexia; cornea, conuctiva, lids were inspected using the 20X. The Fluorescein strips were inserted into the right eye and inspected for corneal and conjuctival damage with borton lamps. Photographs were taken. This was followed by the administration of SLS.

The daily research procedures for the period of five days as follows.

Day 1: The external adnexia; cornea, conuctiva, lids were inspected using the 20X magnification lens. 1ml of lidocain was instilled into the right eye of group A and B animals followed by SLS solution. The animals were observed for 24 hours and photographs taken.

Day 2: The eyes were inspected using the 20X magnification lens. The Fluorescein strips were inserted into the right eye and inspected for corneal and conjuctival damage with borton lamps.

Day 3, 4 and 5: The same procedure was repeated as day 2 and photographs were taken.

2.4 Data analysis

Data was entered into the SPSS 16 version software and graphs were plotted. The abnormalities of the eye classified as either, normal, mild, moderate, severe and very severe according to the grading scoring as described by Asonye and collegues[16].

3. Results

The ocular status of the external adnexia before experimentation was normal in all 3 groups. The eye lid, conjunctiva, corneal epithelial morphology was normal, there was no lacrimation, discharge and edema, blepharospasm and photophobia were absent. Corneal fluorescein stain was transparent and clear (Table 1).

Table 1: Ocular status of the external adnexia of the eye before the commencement of experiment

Parameters	Group A	Group B	Group C
Eyelid status	normal	normal	normal
Conjunctival status	normal	normal	normal
Lacrimation	nil	nil	nil
Corneal epithelial morphology	NAD	NAD	NAD
Cornea Fluorescein	NAD	NAD	NAD transparent and clear
Photophobia	absent	absent	absent
Discharge	nil	nil	nil
Edema	absent	absent	absent
Blepharospasm	absent	absent	absent

Key: NAD- No Abnormality Detected

After experimentation, certain changes were observed in the eyes. These changes were dose dependent especially with group C animals instilled 10mg/ml of SLS (See Table 2).

On day One there was mild swelling of the eyelid, mild hyperemia in conjunctiva, mild tearing, and corneal fluorescein staining showed mild staining. Mild discharge, photophobia and edema were observed in group C than in group B which were particularly less noticeable.

On day two, the severity of the abnormalities increased to mild changes for both groups B and C. However on day three, the status of the entire external adnexia of the eye experience profound changes especially with group C animals which were instilled 10mg/ml of SLS. Lacrimation, corneal epithelial morphology, corneal fluorescein staining and photophobia indicated severe readings.

On day four, the severity as indicated in Group C started dwindling towards moderate levels while for group B it sort of stabilized.

On day five, the moderate changes were sustained but not exacerbated for group C in comparison with group B which virtually reversed to the day one status.

From day one to five, there were no changes observed on the external adnexia of the eye of animals in the control group which were administered normal saline.

The effect of SLS was more significant in the group C (10mg/ml) than in those of group B (5mg/ml) compared to the control group A which had no noticeable changes (No instillation with SLS).

Table 2: Ocular status of the external adnexia of the eye after five days of SLS instillation

	Day 1		Day 2		Day3		Day 4		Day 5		Control
Parameters	Group B	Group C	Group B	Group C	Group B	Group C	Group B	Group C	Group B	Group C	Group A
Eyelid status	1	2	2	2	2	3	2	3	1	2	0
Conjunctival status	1	2	2	3	2	3	2	2	1	2	0
Lacrimation	1	2	2	3	3	4	2	2	1	3	0
Corneal epithelial morphology	1	2	2	3	3	4	2	3	2	3	0
Cornea Fluorescein	1	2	2	3	3	4	2	3	2	3	0
Photophobia	1	2	2	3	3	4	2	3	1	2	0
Discharge	1	2	2	2	2	2	1	2	1	2	0
Edema	1	2	2	3	3	3	1	2	1	2	0
Blepharospasm	0	2	1	2	1	2	1	2	0	1	0

Legends: Grading score for ocular status: 0: normal, 1: mild, 3: moderate, 4: severe 5: very severe (See reference [16]).

4. Discussion

The external adnexia of the eye which includes the cornea and conjunctiva can be portrayed as the boundary between our body *vis-à-vis* the special sense organ-the eye and the environment. The cornea specifically is of great significance and could be described as one of the most important or vital tissues of the eye[17]. This is because apart from being a paramount optical media the cornea plays sensory, protective and nutritive role in the eye. Corneal metabolism is quite vital for normal vision. More so, apart from refracting light, the cornea is involved in the control of light that enters the eye. However, the function of and integrity of the cornea could be disrupted in toxic conditions. This is because, apart from the numerous functions of the cornea, it is quite a fragile tissue, easily susceptible to xenobiotics.

SLS is alluded as one of the universal chemicals in today's modern world. It has a wide variety of applications in household, hygiene, industrial processes and research. As a good surfactant, it is increasingly being used in high concentration in most detergents

leading to increase exposure to the body. Investigation on the veracity of SLS on the body showed SLS not to be safe since it may alter protein formation and inhibit healing of would around the eye. SLS could also lead to general irritation of the ocular tissue, swollen eye lids. Animal studies have shown SLS to have a lethal dose of 0.8 to 110g/kg in rats[18].

As indicated in this study, an increase in concentration of SLS is directly related to an increase in corneal damage as the effect of SLS on the eye was more evident in group C animals (10mg/ml) than in group B (5mg/ml). Also, the effect of SLS increases with time. The effect was more evident on day three but reduced on day five. This suggests that SLS may accumulate in the tissues of the eye and lead to chronic toxicity. The severity of the effect is more prominent after 72 hours. This accumulation can lead to severe tissue damage in the eye which eventually may lead to blindness.

Most corneal damages are usually due to chemical toxicity although they could be caused due to vitamin A deficiency [19] and contact lens wearing [20]. SLS has been shown to be toxic not only to the eye but also to the skin. Application of 10% to 30% caused skin corrosion and severe irritation [21]. A study showed that about 5% of SLS caused damage when applied to the pinna of albino rabbit [22].

5. Conclusion

From the results obtained, SLS is shown to be toxic to the eye and increased concentration can lead to severe damage of eye tissue. This study has exposed the effect of SLS to the eye and therefore, a recommendation of minimal concentration in cosmetics and household hygienic detergents that can get direct contact with the eye. Also, it is recommended for users of these household consumables to void direct contact of these products with the eye.

Conflict of interest

The authors declare that there is no conflict of interest associated with this work.

Contribution of authors

We declare that this work was done by the authors named in the article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors

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