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EXCESS TEARING IS NOT THE ONLY RESPONSE OF HUMAN EYE TO AIR POLLUTANTS !

R. SARIRI* and Z. SANEI

Department of Biology, Gilan University, RASHT, IRAN

ABSTRACT

Toxic gases such as carbon monoxide, ammonia and nitric oxide present in a polluted weather could act as strong risk factor for coronary heart disease, increased white blood cell count, higher levels of hemoglobin, higher level of cholesterol, lower levels of high density lipoprotein, lower blood pressures and less body mass. Air pollutants may also increase the risk of several eye diseases, including macula degeneration, dry–eye syndrome, glaucoma and cataract. The toxic effect of carbon monoxide is the most important factor in damaging ocular tissue. In this research we investigated the change in tear protein electrophoretic pattern in a group of representative people who lived in a highly polluted weather due to excess traffic and industrial activities and compared to a similar group who lived in a clean weather part of the city. 100 volunteers, 50 living in the city center of Tehran, 50 subjects in the same age range who lived in a village at north of the country. The subjects, all female and aged 20–30 years old, filled a questionnaire in order to get some information about their general health and history of eye complications. Total tear proteins and lysozyme concentration were measured and the proteins separated by sodium dodecyl sulfate–polyacrylamide gel electrophoresis (SDS–PAGE). The results showed some alternations in in tear protein pattern of Tehran citizens (Group I) as compared to the village people (Group II). The number of electrophoretic bands in tears of group I was about 25% more than those of group II. The changes observed in tear proteins of group I, i.e. highly polluted air citizens can explain more incidences of dry–eye syndrome observed in this part of the country.

Key words : Excess tearing, Human eye, Air pollutants

INTRODUCTION

Human eyes are subjected to many made and natural environmental changes. Emissions of motor vehicles, for example, are a major source of heavy metals[1]. On the other hand, many chemicals originated from industrial and agricultural activities as well as dust and pH changes are other causes of un–natural environment condition that may affect human eyes. Cigarette smoking has long been recognized as a strong risk factor for coronary heart disease and cerebrovascular disease[2–5]. Recently, the problem of passive smoking as a health risk has widely been discussed[6–8]. Although detailed information on the role of passive smoking on hemostatic parameters is still limited[9], Schmid *et al*[10]. investigated the effect of passive

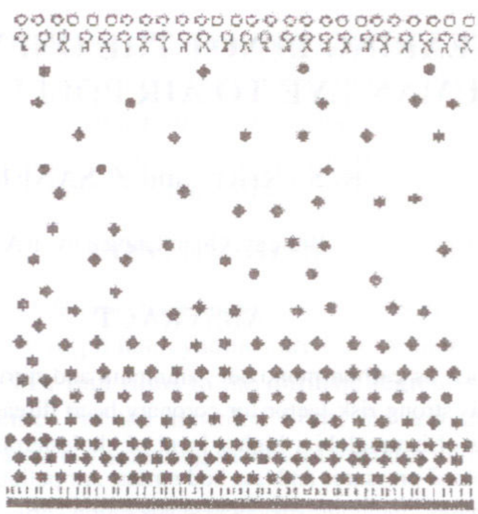

Figure 1. The three layer structure of human tear film

smoking on platelet thromoxane and stated that passive smoking may activate thromboxane A_2 release from the platelets, contributing to the development of hemostatic imbalance. Cigarette smoking and passive smoking could also be a risk factor in several eye diseases, including macula degeneration, glaucoma and cataract. Ischemic, toxic and oxidative effects of cigarettes play an important role in damaging ocular tissue. Dry–eye syndrome has a high frequency of occurrence among cigarette smokers, even passive smokers, compared to non–smokers. The effect of air pollution on human health is suggested to be similar to that of passive smoking and most commonly lead to dry eye syndrome.

Even though the human tear film is very thin, it is composed of three distinct layers (Figure 1) and attains its thickness from the moment after the blinking, slight thinning of the film as a result of the evaporation may be observed[11].

The superficial lipid layer is principally derived from the tarsal (meibomian) glands. The aqueous phase is wholly derived from the main and accessory lachrymal glands, while the mucus layer is derived from the conjunctiva goblet cells. The function of the lipid layer is the reduction of evaporation from the aqueous phase[12]. It is, however, suggested that the non–polar nature of the surface layer is an important factor in preventing surface contamination of the film with highly polar skin lipids.

The aqueous phase of the tears contains a wide variety of organic and inorganic substances. In addition to the principal inorganic (Table 1), as many as sixty proteins are present in the tears (Table 2), together with a variety of biopolymers, glycoproteins, glucose and urea[13, 14]. Stability and functionality of tear film plays an important role in ocular surface diseases[15]. Dry–eye patients typically suffer from discomfort, burning, irritation, photophobia and blurred vision, and have an increased risk of corneal infection and resulting irreversible tissue damage[16].

Table 1. Average concentrations of electrolytes in human tear

Electrolyte	Concentration (mmol/lit)
Na^{+}	80–170
K^{+}	6–42
Ca^{++}	0.3–2.0
Mg^{++}	0.3–1.1
Cl^{-}	106–135
HCO_3^{-}	26

Table 2. Average concentrations of some important tear proteins

Protein	Average Concentration (mg/100 mL)
Total	751
Lysozyme	236
Albumin	130
Tear specific pre–albumin	123
Lactoferrin	184
Immunoglobulin A	30
IgG	12.6
IgM	0.086
IgE	0.01

A wide range of research works have revealed that many tear film components, play a significant role in diagnostic of ocular surface disease caused by air pollution or smoking and in development of new therapies. In general, air pollution damage to human body may be observed most likely around large cities. A change in tear protein pattern is likely to be a general response of tears to the uptake of toxic amounts of heavy metals, high and low temperature, wounding, pathogens, UV radiation and gases. In this study, we used electrophoresis technique to compare the tear protein pattern individuals lived in environmentally different places in order to assess the effect of air pollution on eye health.

Methods

Two groups of 100 volunteers all female and aged 20–25 years with no eye problems entered the study. Group I lived in Tehran, the big Capital of Iran with highly polluted air due to car traffic and various industrial activities, and Group II were from a village in northern Iran with clean, fresh air that was far from those kinds of pollutants. Tear samples were collected from lower cul–de–sac after stimulation with onion vapor using Schrimer strips. The samples were diluted with sterile saline by dipping the strips in 10 µL of the saline that was then used for electrophoresis. The diluted tear samples were marked and stored at –20°C until all samples were collected and ready for examination. Care was taken so that the total storage time for each sample did not exceed 10 days, as the storage period may affect the protein composition of the tears[17]. Total tear protein was measured spectrophotometrically using the modification of two known protein assay methods, Lawry micro assay and Buiret assay methods and the necessary corrections were made for the dilution[18, 19]. 5 ml of each tear sample was then mixed with equal volume of sample buffer and applied to the polyacrylamide gel after being processed by boiling the resulting solution for 2 minutes[20, 21].

RESULTS

The results of SDS poly acrylamide gel electrophoresis using broad range molecular weight as standards showed some differences in protein patterns between the two groups. Group I showed a few protein bands in the range of 66 KD that was not present in tears of Group II (compare Figures 2 and 3). The 14.4 KD band, typical of tear lysozyme was slightly deeper in the case of Group I, indicating an increase in its concentration. The average values of total tears protein were 5.55 mg/mL and 4.56 mg/mL, respectively for the two groups.

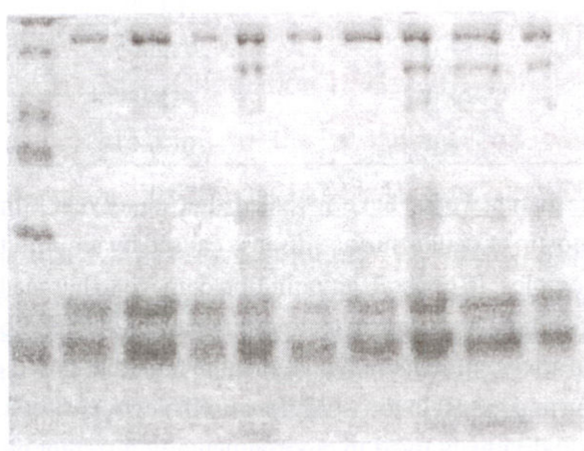

Figure 2. The electrophoresis pattern of tear proteins of people lived in Tehran. The first band on the left is broad range protein molecular weight markers

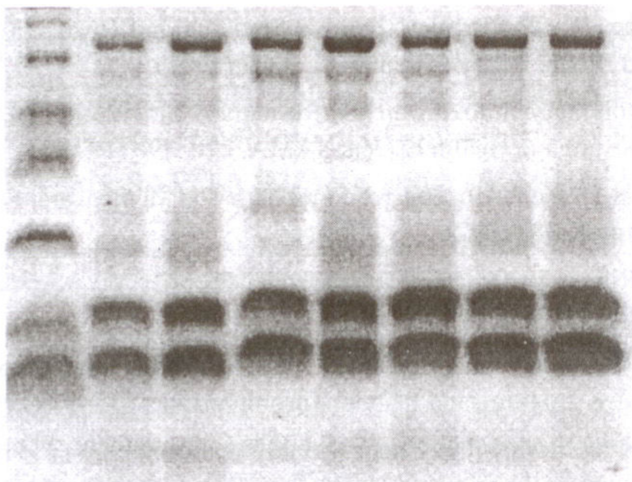

Figure 3. The electrophoresis pattern of tear proteins of people lived in a northern village with clean air. The first band on the left is broad range protein molecular weight markers

CONCLUSIONS

Based on the results it is concluded that the air pollutants can adversely affect the tear proteins causing a total protein increase. It was also shown from the electrophoresis bands that the concentration of tear lysozyme is increased in the tears of people lived in polluted weather, but lower lysozyme activity obtained from the specific tests indicate that lysozyme has lost some of its biological activity due to the toxic effects of gases present in polluted air. Since lysozyme is the antibacterial tear enzyme, the reduction in its activity may lead to serious infectious eye problems. Beside some proteins, mostly immunoglobolines were also appeared in the tear electrophoresis patterns of subjects who lived in highly polluted weather area. This may be due to the irritation caused by toxic gases present that may release some of serum derived proteins into the tears and also the response of tears to the toxic pollutants.

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