Ophthalmic Problems at High Altitude

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Abstract. Cardio-pulmonary and physical endurance aspects of high altitude problems have been studied well but not much attention has been paid to the ocular aspects of the problems. 250 cases inducted to a high altitude area in the northern region were examined for ocular parameters within a week of induction and at varying intervals thereafter. Blurred vision was complained of by a number of cases who also suffered from other symptoms of transient mountain sickness. A group of cases who developed acute pulmonary oedema showed fundus changes by way of venous engorgement, papilloedema and superficial retinal haemorrhages. These changes reversed over a period of time as the acute condition subsided. Another group remained asymptomatic but their fundii showed neovascularisation and exudation in addition to retinal haemorrhages. The aetiopathogenesis of these two kinds of changes and other changes is discussed.

1. Introduction

Interest in high altitude problems has been increasing over the years with more and more people taking to mountaineering. Studies have been directed mainly towards physical endurance and cardio-pulmonary aspects. The whole problem assumed special importance for the armed forces following the deployment of troops in high altitude border areas in the north. Singh[1] reported 1,925 cases of acute mountain sickness and found retinal venous engorgement and papilloedema in a few of these cases. Frayser[2] found retinal haemorrhages in some subjects studied in the laboratory at an altitude of 17,500 feet. Schumacher[3] also noticed retinal haemorrhages in some individuals who had spent up to 24 days at or above 14,000 feet. Sharma[4] described the ophthalmic problems at high altitude in general. In the present study which is still continuing, cases were examined within a few days of their arrival at

high altitude. They were re-examined after they had stayed at altitudes varying from 12,000 feet to 17,500 feet for varying length of time. Both organic as well as functional aspects have been studied.

2. Basic Aspects of High Altitude Physiology

Two things relevant to the present study are the diminution of barometric pressure and low oxygen tension at high altitude. The amount of oxygen in the atmosphere remains constant at 20.93% up to fairly high altitude. The percentage of oxygen in the ambient air is the same at high altitude as it is at sea level. However, gas is compressible, and this means that the number of molecules that a unit volume contains is greater at sea level than at high altitude. Barometric pressure which depends on the molecular concentration of the air decreases with increase in altitude. This in turn results in the partial pressure of oxygen in the ambient air at high altitude PO_2 getting reduced. The relation between altitude, barometric pressure and air (and oxygen) pressure as a percentage of that at sea level is shown in Fig. 1.

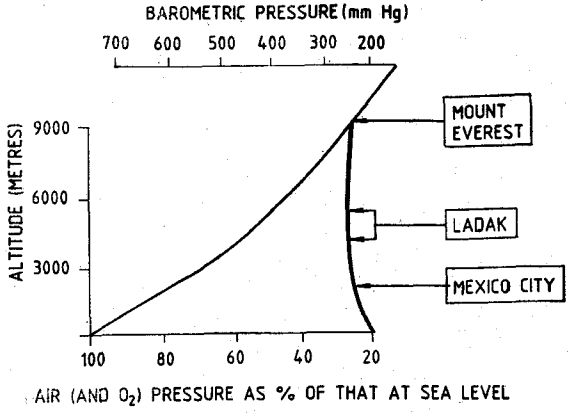

Figure 1. Diagram showing relation between altitude, barometric pressure and air (and oxygen) pressure as a percentage of that at sea level (after Frisancho 1975).

3. Methods and Material

250 personnel in the age group of 25-45 years inducted by air/road in a station in the northern region situated at an altitude of 11,550 feet were examined within a week of their arrival. Visual acuity, colour vision, field of vision, muscle balance, tonometry, ophthalmodynamometry and fundus examination was carried out in all. Thereafter they were transported or marched to outposts by surface route. Those with any retinal pathology were excluded from the study. Those who developed high altitude pulmonary oedema or transient effects of high altitude were re-examined

for some of the above parameters. Others were examined if they complained of any visual symptoms or otherwise after intervals of 3-4 months for one year or more.

4. Observations

4.1 200 cases were inducted by air and 50 by road. Of these, 75 cases (37.5%) suffered from transient effects of high altitude by way of light headedness, sleeplessness and mild breathlessness. On further questioning they also admitted of having blurred vision at times lasting from 10-20 seconds. This was no longer felt after 3-4 days of arrival. Those inducted by road did not suffer from any transient effects of high altitude.

4.2 Fundus examination of 75 cases of high altitude pulmonary oedema (30 out of this study and 45 others) revealed papilloedema of 3-4 diopters in 15 cases. Venous engorgement was found in all cases. 40 cases showed superficial flame shaped retinal haemorrhages around the disc. Fig. 2 shows the fundus photograph of one such case taken in a hospital after evacuation to the plains. In five cases, there was a large pre-retinal haemorrhage. With the improvement in condition, the disc and retinal changes reversed fully in 4-6 weeks time.

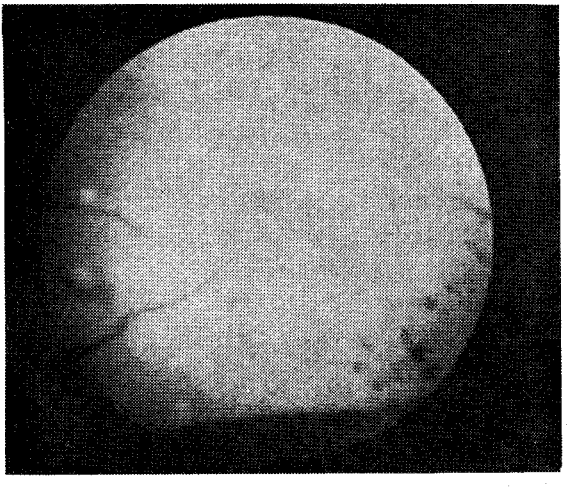

Figure 2. Fundus photograph showing superficial retinal haemorrhages and a pre-retinal haemorrhage in a case of high altitude pulmonary oedema.

4.3 Examination of the asymptomatic patients revealed that 30 had scattered, flame shaped and splinter haemorrhages, neovascularisation of varying degrees and sheathing of vessels. Critical review of these cases revealed that they had been operating at altitudes above 14,000 feet.

4.4 Ocular tension varied between 15 mm Hg to 22 mm Hg. However, five proven cases of glaucoma who were well controlled with 2% Pilocarpine drops in the plains went out of control. They had to be evacuated. In one officer-patient, the angioscotoma increased over a period of six months.

4.5 None of the cases showed any change in colour vision when compared with original findings. Muscle balance tended to show esophoria but it was well controlled and no case broke into esotropia.

4.6 Ophthalmodynamometry in non-symptomatic patients showed the systolic pressure of central retinal artery to be between 65-100 mm Hg and diastolic pressure between 35-65 mm Hg on initial as well as re-examination.

5. Discussion

Transient effects of high altitude were found to be more in those inducted by air. These patients also had transient blurred vision. Those inducted by road had no visual disturbance. It is generally agreed that diminution of barometric pressure and lack of oxygen are responsible for these symptoms. These may be partly or wholly overcome by resorting to oxygen inhalation. But in view of their transient nature and extent of the requirement of oxygen, it is practically not possible. Helicopter crews and passengers at these altitudes, however, do need oxygen puffing to escape these effects.

The organic changes of papilloedema and retinal haemorrhages associated with high altitude pulmonary oedema reversed in all cases. According to Muller[5], they are the result of rapid increase in intra-cranial pressure causing the effusion of CSF into the optic nerve sheath, resulting in compression of central retinal vein and retinal venous hypertension. Raised CSF pressure was found in a number of cases of high altitude pulmonary oedema by Singh[1]. Sutton[6], however, feels that cerebral oedema raised the intra-cranial pressure which causes increased pressure in retinal veins. The hypoxic retinal capillaries unable to stand this pressure give way resulting in splinter and flame shaped haemorrhages. It is natural, therefore, for these changes to reverse with the return of CSF pressure to normal. The retinal haemorrhages with neovascularisation found after longer stay at high altitude and producing no symptoms as found in 30 cases would appear to be the result of hypoxia of the retinal vessels rather than any rise in CSF pressure as happens in cases of pulmonary oedema. A parallel can be drawn here between this and the hypoxia found in retinal vein thrombosis producing neovascularisation possibly due to the release of a chemical vasoproliferative factor. These effects therefore will be more in those who stay longer at high altitude. These changes are not reversible. Goswami[7] has made similar observations.

Variation of ocular tension between 15-22 mm Hg would show that possibly high altitude has got no effect on aqueous production or outflow in normal persons. But

destabilisation of glaucoma control inspite of pilocarpine in five proven cases of glaucoma calls for further studies particularly with reference to facility of aqueous outflow at high altitude. Topographic studies should be undertaken. The pressure of central retinal artery does not seem to vary very much from the normal values as shown by ophthalmodynamometry. It will be desirable to study the retinal artery pressure in cases of pulmonary oedema as well as to see if there is any difference. Muscle balance seems to be affected slightly with a tendency towards esophoria but no break down to tropia has taken place in this study.

References

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