PATHOLOGY

Effect of Blood-letting on Chronic Mountain Sickness

In 1928, Monge[1,2] described the occurrence in the Peruvian high-altitude areas of a disease characterized by an excessive polycythaemia (greater than usual erythropoietic response to the degree of existing hypoxia) and congestive symptoms, both relieved on descent to lower altitudes. This disease, which may develop after years of residence at high levels or in natives born and living in highlands, has been called chronic mountain sickness or Monge's disease[3,5]. The present report describes the effects of blood-letting on the oxygen saturation, CO_2 pressure and *p*H in the arterial blood of patients with chronic mountain sickness living in Cerro de Pasco, Perú, at an altitude of 4,300 metres above sea-level.

The studies were carried out in the Cerro de Pasco Laboratory (4,300 metres) of the Instituto de Investigaciones de Altura. Three cases of chronic mountain sickness were selected on the basis of congestive symptoms, an arterial oxygen saturation (HbO_2 percentage) of less than 81 per cent, which is the normal figure for a similar altitude reported by Hurtado and Aste[6], and a haematocrit of more than 70 per cent. In addition, they all had an arterial pCO_2 above 32·5 mm Hg, which is the average figure for Cerro de Pasco found by Monge *et al.*[7]. This last characteristic corresponds to a condition of hypoventilation recently described by Hurtado[8] as existing in these cases. The subjects were high-altitude natives. They slept in the laboratory the night before the experiment in order to assure basal conditions. Puncture of a brachial artery was done using a standard anaerobic technique and the blood *p*H was read immediately in an Astrup '*M*4' micro blood *p*H meter. The blood pCO_2 was determined using the micro-equilibration technique of Astrup[9]. The HbO_2 percentage was determined in the Van Slyke apparatus. The determination of the O_2 capacity was carried out by tonometer equilibration at pCO_2 40 mm Hg and pO_2 200 mm Hg. After the arterial puncture was finished an indwelling trocar was inserted in an arm vein and a variable amount of blood was withdrawn (see Table 1). The arterial blood measurements were repeated 24 h later.

Table 1 contains the data on HbO_2 percentage, pCO_2, *p*H and haematocrit of each subject before and after bleeding. It can be seen that the values after bleeding do not show important differences in cases 2 and 3. Case 1 showed a drop in HbO_2 percentage from 66·2 to 60·8 with no significant change in *p*H or pCO_2. This case is interesting because the patient had, in addition to congestive symptoms, a moderate degree of heart failure. He had a drop in haematocrit from 76 to 68 in spite of a moderate bleeding of 600 ml. The three patients did not show any improvement in their symptomatology after blood was removed.

The excessive polycythaemia of chronic mountain sickness has been attributed to the increased arterial blood unsaturation secondary to hypoventilation (Hurtado)[8]. The purpose of the present work was to test the hypothesis of a primary excessive polycythaemia and secondary hypoventilation due to embarrassment of the cerebral circulation and activity of the respiratory centre. Our results show that 24 h after venisection the changes in pCO_2 were not significant and in one case there was a drop in HbO_2 percentage. These preliminary results contradict the hypothesis of primary excessive polycythaemia and secondary hypoventilation. As bleeding is often followed by a sense of well-being in cases of chronic mountain sickness, future studies are needed, testing different post-bleeding periods and studying their effect on other physiological parameters such as the elevated pulmonary arterial pressure found by Rotta *et al.*[10] and Peñaloza *et al.*[11] in these cases.

Table 1. Arterial Blood Values in Cases of Chronic Mountain Sickness before and after Venisection

Patient		HbO_2 (%)	*p*H	pCO_2 (mm Hg)	Haematocrit (%)	Bleeding (ml.)
1	*b*	66·2	7·429	39	76·0	600
	a	60·8	7·429	37	68·0	
2	*b*	73·6	7·393	41	76·0	750
	a	74·5	7·419	42	74·0	
3	*b*	72·8	7·410	38	80·5	1,300
	a	74·7	7·428	36	72·5	

b, before bleeding; *a*, 24 h after bleeding.

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Experimental Tumorigenesis in the Hamster Cheek Pouch

The cheek pouch of the Syrian hamster (*Mesocricetus auratus*) has been used in many investigations involving circulation[1–3], hetero- and homo-transplantability of normal tissues and neoplasms[4–7], histochemistry[8,9] and chemical carcinogenesis[3,8–10]. Salley[10] showed that experimental squamous cell carcinomata could be produced in the hamster's cheek pouch by painting with 9,10-dimethyl-1,2-benzanthracene. Delarue *et al.*[3] reported that they obtained fibrosarcomata nine months after subcutaneous implantation of paraffin pellets containing DMBA in the cheek pouch. We have reported[11] that a single subcutaneous injection of 3,4,9,10-dibenzpyrene at the nape of the neck induced fibrosarcomata in the hamster. The primary purpose of this investigation was to determine whether the subcutaneous tissue of the hamster's cheek pouch was as susceptible to the action of the chemical carcinogen.

One hundred and twenty female hamsters, each weighing 75–100 g, were divided among six experimental groups; the animals were lightly anaesthetized and the right cheek pouches were exteriorized. Each pouch received a single subcutaneous injection of 3,4,9,10-dibenzpyrene which had been dissolved in trioctanoin at doses of 0·25 mg, 0·50 mg, 1·0 mg, 1·5 mg, 2·0 mg or 2·5 mg/hamster in an injection volume of 0·2 ml. for five groups. At the maximum concentration it was administered at 0·4 ml. The number of usable hamsters was reduced to 81 due to host mortality in all injected groups. They were examined weekly until death and the tumour was removed at autopsy for microscopic examination. A diet of Wayne laboratory chow was provided, with water *ad libitum*.

The number, incidence and average latency period of all observed tumours and the survival of tumour-bearing hamsters are tabulated in Table 1. Administration of 3,4,9,10-DBP at the doses used resulted in the induction of subcutaneous fibrosarcomata at the site of injection by the seventh week. The cumulative incidence was as follows: 0·25 mg/hamster, 85 per cent; 0·50 mg/hamster, 87 per cent; 1·0 mg/hamster, 100 per cent; 1·5 mg/hamster, 100 per cent; 2·0 mg/hamster, 100 per cent; and