Leucocyte Changes in Rodents Exposed to Cold With and Without Restraint

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ABSTRACT

The white blood cell picture was determined in adult mice and rats with and without restraint. In the mouse both cold and restraint resulted in lymphopenia. When the stresses were applied simultaneously the effect was additive. Restraint in the mouse also caused a reduction in the polymorphonuclear elements. In the rat, restraint produced lymphopenia but contrary to the mouse the stress response of the polymorphonuclear leucocytes was a slight increase rather than a decrease. The total heart white blood cell count was much lower in the mouse than in the rat. Cold was the more severe stress for the mouse, whereas only restraint appeared to be effective in the rat. The possible mechanisms responsible for these treatment and species differences are discussed.

METHODS AND MATERIALS

The adult male mice (18-20 gm) of the Bagg Albino strain and the adult male rats (200-225 gm) of the Sherman strain were each divided into four experimental groups. In order to study the species differences the white blood cell responses of both rats and mice were studied at room temperature and in the cold (3°C ± 2°C, still air, high humidity), with and without restraint. The technique used in producing the restraint has been previously described (4-6). In brief, this consists of lightly restraining the animals in cylindrical wire restraining cages in an essentially normal position. Initial and terminal temperatures were taken with thermometers inserted sufficiently far in the rectum to measure deep visceral temperature. The 1-hour exposure for the mice and the 3-hour exposure for the rats were sufficient to reduce the body temperature to 16°C ± 2 in the animals exposed to the cold. The nonrestrained animals were exposed similar periods of time. Immediately after the exposure the animals were stunned by a blow to the head and blood drawn from the exposed left ventricle. To prevent blood and body fluids of the injured areas from reaching the heart a hemostat was clamped on the neck. The white blood cell counts and differentials were obtained by the usual methods.

RESULTS

Group Treatment Comparison. Mouse.

Both cold (P < 0.01) and restraint, (P < 0.10) when applied individually, effect a leucopenia which was primarily the result of a lymphopenia (fig. 1). Under these experimental conditions cold was a greater stress stimulus than was restraint. It is further noted that when the stresses were applied simultaneously the effects were approximately additive.

Rat. The cold exposure was not a sufficient stress to effect a change in the leucocyte picture (P > 0.30). Restraint, however, when applied alone (P < 0.05) or with cold

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Fig. 1. Leucocyte counts of the mice. A. Animals maintained at room temperature unrestrained. B. Animals restrained at room temperature. C. Animals maintained in the cold without restraint. D. Animals restrained in the cold until a body temperature of 16°C ± 2. Black bars—the total white blood cell count. White bars—the lymphocyte count. Stippled bars—the polymorphonuclear cell count.

(P < 0.03) resulted in a leucopenia. This leucopenia was due entirely to a lymphopenia as the polymorphonuclear leucocytes, if they were altered at all, were slightly increased (fig. 2).

Species Comparison. In all experimental groups the total leucocyte counts from the blood of the heart in the mouse were only about 50% of those in the rat. In the mouse there was a definite reduction in the polymorphonuclear elements with cold exposure with or without restraint. This is in marked contrast to the response of the rat which showed, if anything, a slight increase in the polymorphonuclear elements. Under these experimental conditions cold was the greater stress for the mouse while the rat apparently responded only to the stress of restraint.

DISCUSSION

It is well known that the peripheral white blood cell counts of the rat and mouse are not dissimilar. The data reported herein, however, show a marked difference between the leucocyte counts of the heart blood of the two species. In both species there is a lower count for heart blood compared to peripheral blood. Because the peripheral counts in the two species are similar the marked differences in the heart white blood cell counts might well reflect a difference in the retention of the leucocytes in the peripheral circulation.

Both stresses, when sufficiently intense, resulted in a lymphopenia. These data are in agreement with the work of Elmadjian and Pincus (1), Finesinger et al. (2) and Giaja (3). The effect of stress in the rat on the polymorphonuclear elements is not at variance with the results of Giaja (3). In the mouse, however, there was a marked decrease in the concentration of these cells. This species difference may be the result of a different response of the terminal vascular bed of the two species which, as indicated above, might also result in the different heart white blood cell counts.

There are two general body responses to these stresses which might account for the changes in the white blood cell picture. In general the responses observed are those which would be expected on the basis of an adrenal cortical stimulation. The apparent additive nature of these responses adds credibility to this hypothesis. Cold stress, however, has been shown to effect a change in the peripheral circulation, characterized by impairment (7). Since the white cell distribution may be partially determined by the peripheral circulation (8), it is not unreasonable that changes in this circulation might account for the difference noted here.

There is no clear explanation for the differences in species response.
REFERENCES