Activity-stress gastric lesions in the chipmunk (*Tamias striatus*)

G. P. VINCENT, W. P. PARÉ, K. E. ISOM, and J. M. REEVES
Veterans Administration Hospital, Perry Point, Maryland 21902

Chipmunks were allowed access to a running wheel and fed 1½ h each day. After 13 days of restricted feeding, all activity animals had died and postmortem pathology revealed extensive lesions of the glandular stomach. Food-yoked control animals, not allowed to exercise, very rarely died and showed minimal signs of stomach pathology when autopsied. Circadian running patterns of activity animals indicated a marked increase in diurnal running during restricted feeding. Results indicate that the activity-stress procedure is capable of producing stomach ulcers in a wild animal species.

In the original reports on the activity-stress ulcer, Sprague-Dawley rats were used as experimental subjects (Paré, 1975, 1976; Paré & Houser, 1973). Concern existed in those early studies about whether the activity-stress procedure was instrumental in producing stomach lesions only in the rat. If such were the case, the generality of the findings emanating from experiments using this procedure would be very limited. However, Vincent and Paré (1976a, 1976b) demonstrated that guinea pigs, hamsters, and gerbils, in addition to the rat, also developed stomach lesions when exposed to the activity-stress procedure, thereby demonstrating that activity-stress lesions were not a phenomenon specific to the rat.

This ulcerogenic procedure could be applied to many other animal species in order to determine the limits of its generality.

We were fortunate in obtaining a group of chipmunks from another laboratory and felt that an activity-stress ulcer study would be appropriate since experimental stress ulcer data had never been reported in this animal and the deprivation-induced activity pattern in a diurnal rodent would also be of value to other investigators. Also, we believed that data obtained from this species would be of additional interest since the chipmunk has not been subjected to the same domestication practices that are common to other laboratory animals. Therefore, this study was conducted to determine if chipmunks would develop stomach lesions when exposed to the activity-stress procedure.

METHOD

Subjects

Animals consisted of 12 female chipmunks (101-131 g) and 8 male chipmunks (115-131 g) obtained from the Psychobiological Laboratory of Dr. Curt P. Richter, Johns Hopkins Hospital. These animals had been trapped in suburban Baltimore and had been in Dr. Richter's laboratory for approximately 1 year. Specific age was unknown. The animals had been housed in

activity-wheel running cages while residing in Dr. Richter's laboratory.

Apparatus

Cages were standard running-wheel activity cages (Wahmann Manufacturing Co., Baltimore, Md.). Each activity wheel was equipped with an adjoining cage measuring 25 × 15 × 13 cm. A wheel revolution was recorded on printout counters for each cage. Room temperature was maintained at 22°-23°C, and day-light conditions were artificially maintained between 6 a.m. and 6 p.m.

Procedure

When the chipmunks arrived at this laboratory, they were individually housed in standard single cages for 28 days and had continuous access to food and water. This study used two treatment conditions: an experimental activity-stress treatment and a food-yoke control treatment. Chipmunks were assigned to a treatment condition on the basis of sex and body weight. Thus the experimental and control treatment conditions each had six female and four male animals of equivalent body weights.

Experimental animals were individually housed in running-wheel activity cages for a 4-day habituation period. Control animals were individually housed in standard single cages which did not include a running wheel. During this period, the animals had access to food and water. On Day 5, food was withdrawn from the activity-wheel chipmunks. On Day 6, food was withdrawn from the control animals. On the same day, activity chipmunks were fed for 1.5 h between 9 a.m. and 10:30 a.m. The amount of food consumed was measured. Food control chipmunks were individually matched with an activity chipmunk, and the amount of food consumed by the activity chipmunk in one day was subsequently fed to its food control mate on the next day. The number of wheel revolutions was recorded daily in 2-h blocks for each activity chipmunk. All animals were weighed daily.

When an activity chipmunk died, the stomach was removed immediately and inspected for lesions. The number of lesions was counted and size of lesions was determined by measuring the length and width of each lesion. When an activity chipmunk died, its control mate was killed 24 h later and the stomach inspected for lesions. The study continued for 13 days. Animals still alive at this time were killed with chloroform and stomachs inspected for lesions.

RESULTS

Mean daily running activity scores for both male and

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female chipmunks are illustrated in Figure 1. The advent of the 1.5-h feeding schedule resulted in a substantial increase in daily running activity. All female chipmunks had died after 7 days of 1.5-h feeding, therefore no data points for female animals are shown in Figure 1 after the 7th day. The change in the 24-h daily activity pattern is illustrated by Figure 2. This figure includes 4 days of habituation and the first 4 days of restricted feeding. As a diurnal animal, the chipmunk was more active during the light phase of the light-dark cycle. When the 1.5-h feeding schedule was initiated, the activity pattern during the light phase was augmented and depressed only for the 2-h recording block which contained the feeding period. With the commencement of 1.5-h feeding postprandial activity progressively increased. This is especially the case for the 3-5 p.m. recording block.

Typical stomach specimens are shown in Figure 3. Lesions were observed in the glandular portion of the stomach. Lesions occurred along the rugal folds of the stomachs and were hemorrhagic in character with edema of the mucosa and submucosa. As Table 1 indicates, all activity animals had stomach lesions, whereas only two control animals revealed any lesions. The differences between the activity and control chipmunks with respect to the number and size of lesions were found to be highly significant, $t(1,18) = 5.53$, $p < .000029$, and $t(1,18) = 5.66$, $p < .000022$, respectively. The number and size of

lesions in the chipmunks were extensive as compared to lesions observed in rats (Paré, 1975)

DISCUSSION

Food deprivation in the rat leads to an increase in activity-wheel running (Hall, 1955; Hall & Cannon, 1957; Reid & Finger, 1955, 1957). The diurnal chipmunk, like the nocturnal rat, also demonstrates a significant increase in running after being deprived of food. It should be noted that the 1.5-h feeding period used in this study, similar to that used by Vincent and Paré, 1976b) was a sufficient modification. This longer feeding interval was used because of uncertainty as to how chipmunks would adapt to a restricted feeding schedule. In the present study, female chipmunks were more active than males. We have no data to suggest that this greater activity of female chipmunks was related to estrus changes, because the animals were so wild it was impossible to obtain vaginal smears (Richter, 1976).

Evidently, the chipmunk is susceptible to activity-stress stomach lesions. This is the first report of experimentally produced stress ulcer in the chipmunk and the first time it has been replicated in a wild animal species. The size of the lesions was rather large. In other studies with the rat, cumulative length of activity-stress lesions ranged between a mean of 21.0 mm (Paré, 1975) and

Figure 1. Mean daily running activity of male and female chipmunks. The number in parentheses indicates the number of chipmunks represented by a particular data point.

Figure 2. Mean 2-h running scores for all activity chipmunks. The first 4 days of habituation and first 4 days of restricted feeding are illustrated by solid and hollow data points, respectively.

43.9 mm (Paré, 1977). The average cumulative length of 74.2 mm in chipmunks represents a considerable amount of ulceration. This is even more remarkable when one considers that the chipmunk, weightwise, is roughly half the size of a young adult rat.

These results extend the generality of the activity-stress technique as an ulcerogenic procedure. This report further supports the contention that this procedure is a useful tool for studying ulcerogenic processes in the laboratory.

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Figure 3. Ulcerated stomachs of male and female chipmunks.

Table 1
Summary of Stomach Condition for the Two Experimental Treatments

Treatment	n	Deaths	Chipmunks With Ulcers	Mean ($\pm$ SE)	
				Ulcers Per Chipmunk	Ulcer Length*
Activity	10	10	10	41.6 $\pm$ 14.7	74.2 $\pm$ 8.0
Control	10	2	2	6.4 $\pm$ 4.3	11.4 $\pm$ 7.6

*Millimeters

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