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Comparative Serum Potassium and Sodium Concentrations of Rat Blood Obtained by Different Methods[1] (39517)

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Accurate serum K^+ values are frequently of importance in biologic studies. Hypokalemia or hyperkalemia resulting, respectively, from an excess or a deficiency of mineralocorticoid steroids, is a highly useful index of adrenocortical function. It is also sometimes desirable to quantitate plasma renin activity in studies employing mineralocorticoid hormones, which is best done by rapid decapitation in order to avoid stress-induced hyperreninemia. In our hands the K^+ values of such blood are inordinately elevated, doubtless due to the contribution of intracellular K^+ from traumatized somatic cells.

Recently, it has been reported that blood obtained from the severed tail tip of the rat (1) by the method of Enta (2) yields plasma K^+ concentrations within the normal range, suggesting that this might prove to be a satisfactory procedure.

One method which should yield reliable values owing to the negligible degree of trauma associated therewith is that of cardiac puncture (3, 4). This has, however, disadvantages. Anesthesia is required, the procedure is time consuming, and until skill is acquired animals are frequently killed. The present study was designed to compare values of serum K^+ obtained by these various means.

Materials and methods. These studies were conducted on Sprague-Dawley SPD, Fischer 344, and Wistar WKY and COBS rats. Blood was collected either by rapid decapitation (guillotine), by clipping a small piece from the end of the rat tail (under ether anesthesia although this is not an essential maneuver), or by cardiac puncture of ether-anesthetized rats. Blood was allowed to coagulate and was then centrifuged to obtain the serum. Potassium values were obtained by means of a flame photometer (Beckman Klina Flame). Statistical comparisons were made using Student's two-tailed *t* test.

Results. Experiment 1. This experiment employed groups of young female SPD and Fischer 344 rats that had received one 40-mg pellet of deoxycorticosterone acetate (DOCA) by subcutaneous implantation 73 days prior to sacrifice or had served as unimplanted controls. No other treatment had been given, and the animals had received tap water and purina laboratory chow *ad lib.* At sacrifice the rats were decapitated within 10 sec of removal from their cages. Trunk blood was collected into plastic dishes and allowed to coagulate. Serum Na^+ and K^+ values are given in Table I.

Experiment 2. In this experiment eight Wistar WKY rats which had not been subjected to experimentation, but had been maintained on tap water and Purina laboratory chow were used. Under ether anesthesia, blood was collected first by cardiac puncture and immediately thereafter from the clipped tail. Serum Na^+ and K^+ values are shown in Table II.

Experiment 3. Since the previous experiment had indicated that, while tail blood K^+ values were within the range obtained by others (1), the values were nevertheless higher than simultaneously drawn heart blood, an experiment was undertaken to determine whether a second sample drawn after an interval had elapsed from the first collection would yield truer values.

Eight Wistar COBS rats, which had not been under treatment but had been maintained on normal food and water in the colony, were used. Under ether anesthesia, freely flowing blood was collected from a severed tail tip. Two additional drops were allowed to fall and were discarded. A second collection was then made. The serum K^+ values are shown in Table III.

Discussion. Serum from blood collected

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TABLE I. SERUM Na^+ AND K^+ CONCENTRATIONS IN DOCA-TREATED AND CONTROL SPD AND FISCHER 344 RATS.

Data	SPD		Fischer 344	
	DOCA	Controls	DOCA	Controls
N	8	8	9	8
Serum K^+	6.55 ± 0.20[a, b]	7.64 ± 0.21	6.12 ± 0.13[b]	7.13 ± 0.10
Serum Na^+	124.12 ± 0.81	122.62 ± 0.65	125.33 ± 1.40	122.50 ± 0.78

[a] Mean ± SEM. Values are given as milliequivalents per liter.
[b] Significantly different from control values ($P < 0.002$).

TABLE II. SERUM Na^+ AND K^+ CONCENTRATIONS OF HEART AND TAIL BLOOD.

Data	Heart blood	*P*	Tail blood
N	8		8
Serum Na^+	143.25 ± 0.65[a]	N.S.	143.50 ± 1.11
Serum K^+	4.91 ± 0.07	<0.0001	6.32 ± 0.16

[a] Mean ± SEM. Values are given as milliequivalents per liter.

TABLE III. SERUM Na^+ AND K^+ CONCENTRATIONS IN SEQUENTIALLY DRAWN SAMPLES OF TAIL BLOOD.

Data	First sample	Second sample
N	8	8
Serum Na^+ (mEq/liter)	142.35 ± 0.54[a]	142.97 ± 0.62
Serum K^+ (mEq/liter)	5.76 ± 0.28	5.50 ± 0.10

[a] Mean ± SEM. Values are given as milliequivalents per liter.

by cardiac puncture had the lowest and least variable K^+ concentration and a normal Na^+ concentration. Simultaneously collected tail blood yielded serum with a comparable Na^+ concentration, but a significantly higher K^+ concentration. Without exception serum K^+ values were 1.1 to 2.1 mequiv/liter lower from heart than from tail blood of the same animal. In the second experiment, where extreme care was taken to clip as little of the tail tip as possible in order to prevent undue contamination of blood with extravascular fluid, the serum Na^+ values were quite similar to those obtained by that method previously. Serum K^+ values were somewhat lower and at the upper limit of such values reported by other investigators (1). However, they were somewhat higher than the earlier values obtained by cardiac puncture, and it was evident that no improvement was attained by collecting a second sample after allowing an interval to elapse after collecting the first. In one instance the K^+ values were identical in both samples, in three the first sample was slightly lower than the second, and in four the reverse obtained.

Trunk blood from decapitate animals gave serum that had diminished Na^+ and elevated K^+ concentrations. It was evident that the samples had been significantly contaminated with intracellular fluid high in K^+ and low in Na^+.

"Serum" K^+ concentrations from decapitate rats were, in fact, high enough to have been toxic had they actually occurred. Despite these distortions, the mineralocorticoid effect of DOCA was clearly discernible. Hormone-treated groups had serum Na^+ concentrations that were about 2 mequiv/liter lower and K^+ concentrations about 2 mequiv/liter higher than those present in untreated groups, although in both cases the Na^+ concentration was about 20 mequiv/liter lower than in blood obtained from the heart or tail. This change was sufficient to produce a highly statistically significant depression of serum K^+ in DOCA-treated rats, but the hypernatremia was not great enough to do so because of the much higher normal values for the concentration of that ion.

In general, it appears that elevation of serum K^+ is a reliable index of the degree of cellular trauma incident to blood collection. Although only blood obtained by cardiac puncture appears to yield entirely reliable K^+ values, those obtained from the severed tail tip often fall within an acceptably "normal" range, and even the most unreliable concentrations, those present in trunk blood from decapitate rats, could be used to demonstrate the hypokalemic effects of a potent mineralocorticoid hormone.

Summary. Blood obtained from anesthetized rats by cardiac puncture, severance of

the tail tip, or decapitation, was analyzed for serum Na^+ and K^+. The lowest, least variable, and hence most reliable serum K^+ values were obtained from heart blood. Tail-blood samples gave serum K^+ values which, while often in a plausible range, were substantially higher. Trunk blood collected from decapitates gave inordinately high serum K^+ and low Na^+ values. These, while obviously inaccurate, could still be used to demonstrate the hypokalemic effects of mineralocorticoid hormone. If accuracy is essential, cardiac puncture is the only reliable method among those used for obtaining serum K^+.

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