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RENAL FUNCTION IN DOGS WITH PYOMETRA

7. CALCIUM AND POTASSIUM LEVELS IN DOGS WITH PYOMETRA AND POLYURIA

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The polyuria which is associated with pyometra results from reduction of the renal concentrating ability (*Åsheim* 1963). This reduction appears to depend upon reduced resorption of water in the distal and collecting tubules (*Åsheim* 1964 a). A reduction in the medullary sodium gradient is associated with the dysfunction of the collecting tubules (*Åsheim* 1964 b).

A similar renal dysfunction occurs in conjunction with potassium depletion (*Giebisch & Lozano* 1959, *Manitius et al.* 1960) and with hypercalcemia (*Epstein et al.* 1959, *Manitius et al.* 1960). It appeared from studies on a limited number of bitches that pyometra with polyuria can be associated with hypokalemia (*Åsheim* 1964 a). The series has now been extended to cover serum calcium levels and levels of potassium in plasma and in muscle tissue of pyometra bitches with a depressed concentrating ability.

MATERIAL AND METHODS

Sixty-four pyometra bitches with reduced renal concentrating ability were available. Serum calcium levels were determined for 12 of the bitches and plasma potassium, sodium and osmolarity for all 64. The potassium, sodium, and water contents of muscle tissue were determined for 8 of the bitches. Four of these bitches were re-examined 12 to 15 days after ovariohysterectomy; at that time their clinical state had generally improved considerably.

Clark & Collip's (1925) modification of Kramer & Tisdall's (1921) method was used for the calcium determinations.

Osmolarity of urine (Uosm) and plasma (Posm) has been calculated from freezing point depression. The error of the method has been given elsewhere (Åsheim 1963). Sodium and potassium levels were determined by flame photometry.

The electrolyte content of muscle tissue was determined on biopsy samples. With the bitches under IntraVal[®] and Fluothane[®] anaesthesia a sample of the brachiocephalicus about 1 cm in diam. was excised with a scalpel. After the removal of adventitious tissue, the sample was divided into two portions approximately equally sized. Their weight ranged from 60 to 400 mg. Each portion was dried to constant weight and the lipids extracted with petroleum ether. Sodium and potassium levels were determined by flame photometry after wet ashing with HNO₃ and H₂O₂ and the amounts present expressed as mEq per 100 g fat-free solids (FFS). The values given here represent the mean for the two portions of the biopsy from each bitch.

All these determinations have also been made on clinically healthy bitches with normal renal function. The normal values for calcium are derived from a series of normal animals described in another paper (Persson *et al.* 1961).

The results for the pyometra bitches and the normal bitches have been compared statistically by Student's test.

RESULTS

Table 1 lists the values obtained for osmolarity, plasma sodium and potassium, and serum calcium. Posm and the sodium and calcium levels of the pyometra bitches were similar to those of the normal bitches. The mean plasma potassium content for the pyometra bitches, however, was 3.9 mEq/l and 4.2 mEq/l for the normal bitches. Although this difference is numerically small it is statistically significant ($0.01 > P > 0.001$). After ovario-hysterectomy the mean plasma potassium rose from 3.9 mEq/l to 4.0 mEq/l (Table 1).

If the bitches for which both renal concentrating ability and plasma potassium content were determined are divided into two groups on the basis of the concentrating ability, the group with a max. Uosm less than 750 mOsm/l has a mean plasma potassium level of 3.85 mEq/l ($n = 21$). For the group with a max. Uosm greater than 750 mOsm/l, the mean plasma potassium level is

Table 1. Pre-operative and post-operative osmolarity and electrolyte levels for pyometra bitches and for normal bitches.

<i>Normal bitches</i>				
	Plasma sodium mEq/l	Plasma potassium mEq/l	Serum calcium mEq/l	Plasma osmolarity mOsm/l
Number	21	21	16*	21
Mean	149.0	4.2	5.1	293
Range	141—154	3.7—4.9	4.1—5.9	286—304
Standard error	0.72	0.07	0.15	0.85
Standard deviation	3.3	0.3	0.6	3.9
<i>Pyometra bitches</i>				
Pre-operative				
Number	64	64	12	79
Mean	145.2	3.9	5.5	296
Range	128—161	3.0—4.7	4.2—6.0	277—316
Standard error	0.89	0.05	0.16	0.84
Standard deviation	7.1	0.4	0.6	7.5
P-value	> 0.05	< 0.01	> 0.05	> 0.05
Post-operative (9—15 days)				
Number	23	23		30
Mean	147.0	4.0		295
Range	134—157	3.4—4.7		282—303
Standard error	1.20	0.11		1.17
Standard deviation	5.8	0.5		6.4

* Normal serum calcium values have been taken from a previous paper (Persson et al. 1961).

3.79 mEq/l ($n = 25$). From this it is apparent that there is no correlation between concentrating ability and the plasma potassium level.

There were no differences in the potassium levels in muscle tissue from pyometra and normal bitches (Table 2) in spite of the muscle biopsies having been taken from pyometra bitches with relatively low levels of plasma potassium (mean 3.8 mEq/l). Nor were there any differences between the groups in the sodium and water content.

Four of the eight pyometra bitches in Table 2 were re-examined 12 to 15 days after ovariohysterectomy (Table 3). Mean max. Uosm rose from 824 mOsm/l to 1177 mOsm/l. The mean plasma potassium content also increased from 4.0 mEq/l

Table 2. Sodium, potassium and water content of muscle tissue from pyometra bitches and normal bitches.

<i>Normal bitches</i>			
	Sodium mEq/100 g FFS	Potassium mEq/100 g FFS	Water %
Number	7	7	7
Mean	12.0	33.9	75.0
Range	9.3—16.1	31.1—37.1	73.0—77.1
Standard error	0.87	0.93	0.55
Standard deviation	2.3	2.5	1.5
<i>Pyometra bitches</i>			
Number	8	8	8
Mean	11.4	34.5	74.4
Range	9.0—14.1	31.0—38.4	73.0—78.7
Standard error	0.66	0.89	0.68
Standard deviation	1.9	2.5	1.9

to 4.7 mEq/l. Mean muscle potassium levels remained practically unchanged, 35.6 mEq/100 g FFS before ovariohysterectomy and 35.8 after operation (Table 3).

Table 3. Pyometra bitches. Sodium and potassium content in plasma and muscle tissue and max. Uosm before and 12—15 days after ovariohysterectomy.

Pyometra bitches no.	Muscle tissue				Plasma				Urine	
	Sodium mEq/100 g FFS		Potassium mEq/100 g FFS		Sodium mEq/l		Potassium mEq/l		Max. Uosm mOsm/l	
	pre-op.	post-op.	pre-op.	post-op.	pre-op.	post-op.	pre-op.	post-op.	pre-op.	post-op.
375	13.8	16.3	37.8	35.5	147	143	4.1	5.0	780	1180
381	14.1	17.8	35.1	35.0	140	138	4.0	4.8	980	1130
398	11.7	10.9	38.4	39.5	140	132	3.8	4.1	908	1260
551	9.0	10.7	31.0	33.2	133	147	4.0	5.0	626	1136
Mean	12.2	13.9	35.6	35.8	140	140	4.0	4.7	824	1177

DISCUSSION

The normal serum calcium levels in the pyometra bitches eliminate hypercalcemia as a possible cause of the associated polyuria.

The plasma potassium levels in pyometra bitches are slightly but statistically significantly reduced. There is little agreement on the value of the plasma potassium content as an indication

of a possible potassium deficiency. Some (*Flear et al.* 1957, *Seldin et al.* 1956/57) believe that a potassium deficit does not necessarily need be reflected by a drop in the plasma potassium content. Others maintain that there is a direct correlation between plasma and muscle potassium levels (*Leibman & Edelman* 1959, *Welt et al.* 1960, *Bergström* 1962) .

In any event, determination of the amount of intracellular potassium is a more reliable method of demonstrating a possible potassium deficit (*Welt et al.* 1960). Muscle tissue seems to be suitable for this purpose provided that the same muscle is always sampled; the potassium content of different muscles varies (*Holliday et al.* 1957, *Bergström* 1962). The similar potassium levels in muscle tissue from pyometra and normal bitches and the similarity between the pre-operative and the post-operative samples justify the conclusion that potassium deficiency is unlikely to have any place in the pathogenesis of the depressed renal concentrating ability which accompanies pyometra.

Salt retention can accompany glomerular lesions in human beings and animals (*Merril* 1956, *Remenchik et al.* 1958, *de Wardener* 1961). Since there are often glomerular lesions in bitches with pyometra (*Obel et al.* 1964) it is possible that even in these animals there will be salt retention. The reduced natriuretic response of pyometra bitches to osmotic loading (*Asheim* 1964 c) is a possible sign of tendency towards such a retention. Retention of water concomitant with retention of salt can explain the normal plasma sodium content and osmolarity in pyometra bitches (Table 1). It is conceivable that a possible water retention can explain the depression of plasma potassium content in pyometra bitches and thus even the lack of congruency between the plasma and muscle potassium levels. In dogs, however, the volume of extracellular water could be doubled experimentally without affecting the level of serum potassium (*Scribner & Burnell* 1956).

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SUMMARY

The serum calcium levels are normal in bitches with pyometra accompanied by a depressed renal concentrating ability.

The mean potassium level of pyometra bitches with polyuria is reduced by 0.3 mEq/l ($0.01 > P > 0.001$). There was no correlation between plasma potassium levels and the reduction in renal concentrating ability.

There were no differences in muscle potassium levels between pyometra bitches and normal bitches.

Muscle potassium levels before and after ovariohysterectomy of pyometra bitches were quite similar although the maximum concentration ability was improved after operation.

These results lead to the conclusion that the depressed renal concentrating ability in bitches with pyometra is not caused by hypercalcemia or potassium deficit.

ZUSAMMENFASSUNG

Die Nierenfunktion bei Hunden mit Pyometra.

7. Kalziumgehalt in Serum und Kaliumgehalt in Plasma und Muskelgewebe bei Polyurie verursacht durch Pyometra.

Kalziumgehalt in Serum bei Hunden mit verminderten Konzentrationsfähigkeit infolge einer Pyometra, übereinstimmt mit den Werten für normale Hunde.

Kaliumgehalt in Plasma bei Hunden mit Pyometra-Polyurie ist mit einem Mittelwert von 0.3 mEq/L ($0.01 > P > 0.001$) niedriger als die Werte bei normalen Hunden. Ein Zusammenhang zwischen dem Kaliumgehalt in Plasma und zwischen verminderten Konzentrationsfähigkeit kann man nicht nachweisen.

Die angegebene Kaliummenge im Muskelgewebe wurde in Gewichtseinheiten der fettfreien Trockensubstanz berechnet und war bei normalen Hunden wie auch bei Hunden mit Pyometra-Polyurie gleich.

Kaliumgehalt in Muskelgewebe bei Hunden mit Pyometra ist vor bzw. nach der Ovariectomie übereinstimmend, obwohl sich nach der Operation die max. Konzentrationsfähigkeit verbesserte.

Auf Grund dieser Resultate hält der Verfasser, dass die Verminderung der Konzentrationsfähigkeit der Nieren in Zusammenhang mit Pyometra der Hunde nicht durch die Hyperkalzämie bzw. Kaliumdefizit bedingt wird.

SAMMANFATTNING

Njurfunktionen hos hundar med pyometra.

7. Kalcium i serum och kalium i plasma och muskelvävnad vid pyometra-inducerad polyuri.

Kalciumhalten i serum hos hundar med nedsatt koncentrationsförmåga i samband med pyometra överensstämmer med värdet hos normala hundar.

Kaliumhalten i plasma hos hundar med pyometra-polyuri är sänkt med i medeltal 0.3 mEq/l ($0.01 > P > 0.001$) i jämförelse med värdena hos normala hundar. Någon relation mellan kaliumhalten i plasma och nedsättningen i koncentrationsförmågan kan ej påvisas.

Kaliummängden i muskelvävnad, beräknad per viktsenhet fettfri torrs substans, är lika för normalhundar och hundar med pyometra-polyuri.

Kaliuminnehållet i muskelvävnad hos pyometrahundar före resp. efter ovariectomi är lika trots att max. koncentrationsförmågan förbättras efter operationen.

Av resultaten drar förf. den slutsatsen att nedsättningen av den renala koncentrationsförmågan i samband med pyometra hos hund ej betingas av hyperkalcämi eller kaliumbrist.

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