The Effect of Magnesium Chloride on the Adrenalino-Secretory Action of Potassium Chloride

By

Kazukuni Yamashita, Masaaki Inoue and Hirobumi Akimoto

(山下 一 邦)

(井 上 公 明)

(秋 本 博 文)

From the Department of Physiology, Nagasaki University

School of Medicine, Nagasaki;

Director: Prof. T. Suzuki

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Evidence concerning the antagonistic actions of K and Mg ions on the adrenaline secretion of the adrenal was given by Hazard and Wurmser.¹⁾ They observed in dogs that the elevation of blood pressure evoked by intravenous injection of KCl was prevented by MgCl₂ and assumed that this was attributable to the antagonistic effect of MgCl₂ on the adrenalino-secretory action of KCl.

Their experiment seems to be sufficiently reasonable to know the antagonistic actions of two ions on the cardio-vascular system at least, but we feel there is a need to investigate quantitatively this problem because the blood pressure response is not a specific indicator for the adrenaline secretion of the adrenal.

Thus, the present study was undertaken to elucidate quantitatively whether the accelerated adrenaline secretion causable by KCl is suppressed by MgCl₂.

EXPERIMENTAL

Methods

Dogs, anesthetized by intravenous injection of Evipan-sodium, were used. The operation for collecting the adrenal venous blood was performed through the lumbar route with almost the same technique as that of Satake *et al.*²⁾ The adrenaline content of the blood specimens was determined chemically by the arseno-molybdic acid method of Bloor and Bullen.³⁾ In most experiments the blood pressure was recorded by the mercury manometer connected with the femoral artery.

KCl in a dose of 30–33 mg. per kg. of body weight was injected intravenously in 15 seconds. Twenty to 30 minutes later, a mixture of KCl in the same amount as before with MgCl₂ in an amount of 10 mg. per kg. was again injected in-

travenously in 15 seconds.

Thus, the adrenaline secretion rates after the first and the second injections were estimated and compared with each other. Adrenaline (Merck), dissolved in 1/10 *N* hydrochloric acid solution, was taken as the reference standard.

Results

The data obtained from four experiments are epitomized in Table I.

TABLE I
Effect of MgCl_2 on the Augmented Adrenaline Secretion
Causable by KCl

No. of exp. Body weight and Sex	Adrenaline secretion rate ($\mu\text{g. per kg. per minute}$)					
	Injection of KCl			Injection of KCl plus MgCl_2		
	Before	After		Before	After	
		0-60''	60''-120''		0-60''	60''-120''
1) 8.2 kg. ♂	*	0.09	0.02	0.005	0.01	0.006
2) 11.1 kg. ♂	*	0.31	0.04	0.008	0.009	*
3) 9.9 kg. ♀	0.02	0.11	0.02	0.02	0.03	0.01
4) 17.0 kg. ♂	*	0.38	0.06	0.02	0.10	*

* Immeasurably small

In Exp. 1 the adrenaline content of the blood sample collected before KCl injection was too small to be quantified. After KCl a definite increase in the adrenaline secretion rate was found. In the first 60-second period after the start of injection it was determined as $0.09 \mu\text{g. per kg. per minute}$. With the specimen, which was collected during the second 60-second period, the rate of secretion was determined as $0.02 \mu\text{g.}$

Thirty minutes later, the rate of secretion was estimated as $0.005 \mu\text{g. per kg. per minute}$. Then the mixture of KCl with MgCl_2 was injected. After injection the rate of secretion did not show any definite alteration.

In Exp. 2, the basal rate of adrenaline secretion at the beginning of experiment was immeasurably small. On receiving KCl it was increased. With the specimen collected during the first 60-second period, it was found to be $0.31 \mu\text{g. per kg. per minute}$. In the second 60-second period it was $0.04 \mu\text{g.}$

Twenty-five minutes later, the rate of secretion was $0.008 \mu\text{g. per kg. per minute}$. The mixture of KCl with MgCl_2 was then injected. After the application the rate of adrenaline secretion was determined as $0.09 \mu\text{g.}$ and immeasurably small rate at the first and the second 60-second period, respectively.

In Exp. 3 the initial adrenaline secretion rate was $0.02 \mu\text{g. per kg. per minute}$. By the administration of KCl, the increase in the adrenaline secretion rate up to $0.11 \mu\text{g.}$ was elicited, which was found in the first 60-second period. In the second 60-second period the rate of secretion was $0.02 \mu\text{g.}$

Twenty minutes later, the adrenaline secretion rate of the adrenal was $0.02 \mu\text{g. per kg. per minute}$. Then the injection of KCl plus MgCl_2 was made. By the injection the rate of secretion was not increased definitely.

In Exp. 4, the adrenaline secretion rate after KCl injection was found to be $0.38 \mu\text{g. per kg. per minute}$ in the first 60-second period against immeasurably small rate before injection. In the next 60-second period it was $0.06 \mu\text{g.}$

Twenty-two minutes later, the adrenaline secretion rate was $0.02 \mu\text{g. per kg. per minute}$. By the injection of KCl plus MgCl_2 its value was somewhat increased, $0.10 \mu\text{g.}$ being estimated in the first 60-second period.

From the above results, it was clarified quantitatively that the augmentation of the adrenaline secretion causable by KCl was suppressed or nullified by MgCl_2 .

In most cases the blood pressure fell abruptly after KCl injection and at its lowest level a bradycardia was observed. Then the blood pressure rose again step by step and resumed the initial level. After the injection of the mixture of KCl with MgCl_2 , the blood pressure fell in most cases slightly. Soon, it began to rise and reached the pre-injection level.

SUMMARY

Four dogs, anesthetized with Evipan-sodium, were experimented on. The adrenal venous blood specimens were collected through the lumbar route and were analysed for adrenaline by the chemical method of Bloor and Bullen.

While the administration of KCl in a dose of 30–33 mg. per kg. caused a definite increase in the adrenaline secretion, the injection of KCl in the same dose as before plus MgCl_2 in a dose of 10 mg. per kg. produced no increase or only a small increase in the adrenaline secretion.

From these experimental results, it is concluded that MgCl_2 is capable of antagonizing the accelerating action of KCl on the adrenaline secretion.

We should like to record our gratitude to Prof. T. Suzuki for suggesting the problem.

References

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