手術中の犬における乳酸リンゲル液とデキストロース加乳酸リンゲル液の輸液効果の比較

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Comparative Studies on Lactate Ringer Solution and Lactate Ringer Dextrose Solution in Dogs during Surgery

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ABSTRACT. Experiments were performed to examine the effects of dextrose added to lactate Ringer solution (LR) in dogs under surgical stress conditions. The results were as follows: 1. LR with dextrose (LRD) inhibited the release of NEFA in dogs under surgical stress conditions. 2. LRD increased the content of liver glycogen of dogs under surgical stress conditions. 3. Transfusion with LRD maintained sufficient urine excretion in dogs under surgical stress conditions. From these results, it was suggestd that LRD shold be used rather than LR alone, since the addition of dextrose to LR had favorable effects on dogs under surgical stress conditions.—KEY WORDS: dextrose, liver glycogen, NEFA, surgical stress.

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Lactate Ringer solution (LR) is used as a supplemental extracellular fluid during surgery on samll animals. LR is used to maintain the homeostasis of blood dynamics preventing the occurrence of third space and hypotension. However, liver glycogen level is known to be lowered by fasting before surgery, and that disturbances such as catabolism of body fat and tissue protein can be induced by surgical stress. The decrease in liver glycogen content is also known to impair hepatic fastness against hepatotoxic agents [3]. Miletich *et al.* reported that non-esterified fatty acid (NEFA) released by surgical stress lowered the threshold of arrhythmia induced by inhalation of halothane [6]. Glucose infusion during surgery is considered to reverse the decrease in liver glycogen and prevent the release of NEFA. From these considerations the authors studied the effect of infusion with lactate Ringer dextrose solution (LRD) during surgery on the blood properties, urine volume and liver glycogen content of dogs comparing the results with dogs infused with LR.

MATERIALS AND METHODS

Animals: Twenty healthy mongrel dogs were obtained from the Kawagoe Animal Control Center to examine blood properties, urine volume and liver glycogen content under surgical stress conditions. These dogs were divided into 3 groups of 6 (*LR-20 group*), 6 (*LRD-10 group*) and 8 (*LRD-20 group*) dogs. The dogs were restricted from food intake for 48 hours and water intake for 24 hours prior to the experiment.

Anesthesia and surgery: Under halothane gas anesthesia with premedication of atropine sulfate and induction of thiopental sodium, arterial Pco_2 of the dogs was controlled to maintain 35–40 mmHg using a positive-pressure ventilator. Under these conditions, laparotomy was done. Laparotomy was performed to enhance the surgical stress on the dogs and was conducted as follows. An incision was made on the abdominal midline from the caudal point of the xiphoid process to the cranial edge of the pubis, and all the structures of the intestine were drawn out from the abdomin-

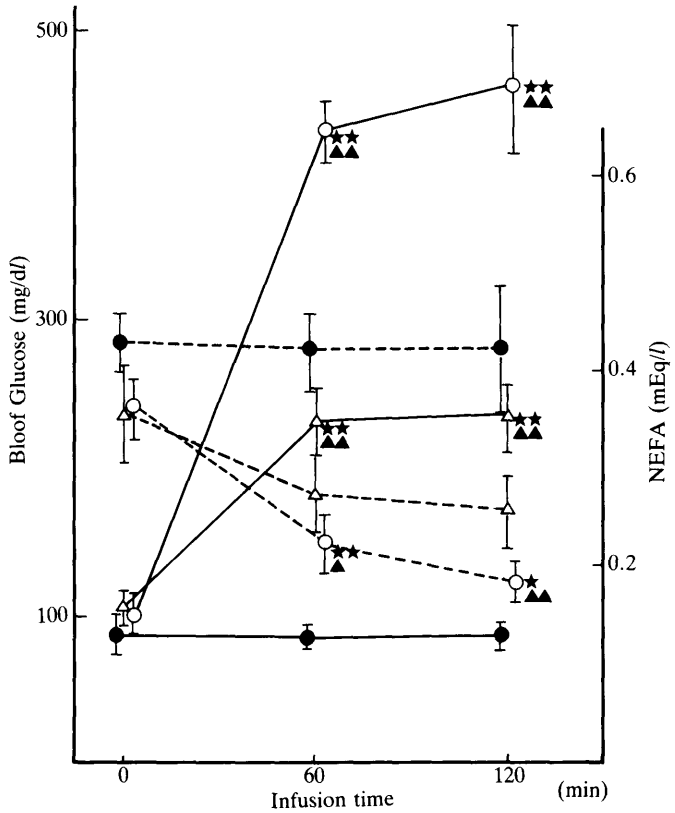

Fig. 1. Changes of Blood Glucose Level and NEFA with Infusion. Each point and vertical bar represent mean±S.D. -●- LR-20 group (n=6), -△- LRD-10 group (n=6), -○- LRD-20 group (n=8). ——: Blood Glucose level, ------: NFEA, * Significantly different from LR ($P<0.05$), ** Significantly different from LR ($P<0.01$), ▲ Significantly different from time 0 ($P<0.05$), ▲▲ Significantly different from time 0 ($P<0.01$).

al cavity and about 1.0 g of the liver was obtained from the left lateral lobe. Immediately after this operation, the dogs were infused with LR or LRD for 120 minutes. The abdomindal cavity was left as it was open until the end of the infusions and another 1.0 g of the liver was obtained.

Intravenous infusion: Immediately after the first sampling of the liver, intravenous infusion with LR or LRD which was a mixture of 9 parts of LR and 1 part of 50% dextrose solution was started as follows. The dogs of the *LR-20 group* were infused with LR at the rate of 20 ml/kg/hr, the *LRD-10 group* with LRD 10 ml/kg/hr and the *LRD-20 group* with LRD 20 ml/kg/hr, for 120 minutes.

Examination of the effect of infusions: Blood samples were drawn from the lateral jugular vein before and 60 and 120 minutes after the initiation of the infusion. The bladder of the animal was emptied by catheterization 30 minutes before the infusion and urine was collected 5 times every 30 minutes after the initiation of infusion. The content of liver glycogen was determined by the method of J. R. Rge and Dailet [1]. Blood glucose and NEFA were determined by the glucose-oxdase method and the modified Duncombe method, respectively. Plasma protein (PP), osmotic pressure, sodium (Na) and potassium (K) levels were

Table 1. Changes in properties of blood plasma

	LRD-10 group n=6[b]			LRD-20 group n=8			LR-20 group n=6		
	0	60	120 min	0	60	120	0	60	120
Protein (g/d*l*)	6.3[a] ±0.37	5.5**▲▲ ±0.42	5.4*▲▲ ±0.22	6.2 ±0.77	4.5▲▲ ±0.58	4.4▲▲ ±0.70	6.0 ±0.89	4.6▲ ±0.34	4.3▲▲ ±0.74
Osmotic pressure (mOsm/*l*)	296 ±39.1	288 ±27.1	293 ±25.6	293 ±10.2	305 ±24.5	303 ±16.1	293 ±35.2	292 ±24.3	283 ±28.7
Na (mEq/*l*)	144.5 ±3.00	142.4 ±1.40	142.1 ±2.53	145.3 ±6.05	139.6 ±6.34	141.1 ±4.50	144.1 ±2.97	143.4 ±2.58	143.3 ±2.34
K (mEq/*l*)	4.09 ±0.45	3.85 ±0.52	3.85 ±0.53	3.52 ±0.31	3.62 ±0.48	3.49 ±0.44	4.10 ±0.23	3.92 ±0.28	4.01 ±0.19

a) Mean±SD.
b) Number of dogs.
* Significantly different from LR-20 group ($P<0.05$).
** Significantly different from LR-20 group ($P<0.01$).
▲ Significantly different from time 0 ($P<0.05$).
▲▲ Significantly different from time 0 ($P<0.01$).

Table 2. Changes of urine volume with infusion

Group	Infusion time (min)				
	0	30	60	90	120
LRD-10 (n=6)[b]	1.96±2.22[a]	2.07±2.22	1.36± 1.02	1.82± 0.70	2.25± 1.29
LRD-20 (n=8)	3.76±2.50	4.93±4.58	16.53±15.89	19.29±11.02**▲▲	26.40±20.80*▲
LR-20 (n=6)	6.08±5.96	2.43±3.06	4.63± 3.57	2.68± 1.91	3.36± 2.66

a) Mean±SD.
b) Number of dogs.
* Significantly different from LR-20 ($P<0.05$).
** Significantly different from LR-20 ($P<0.01$).
▲ Significantly different from time 0 ($P<0.05$).
▲▲ Significantly different from time 0 ($P<0.01$).

determined using a protein refractometer, osmometer, and the Na and K ion-electrode method, respectively.

RESULTS

The changes in blood properties, urine volume and liver glycogen content were observed to know the effects of LRD infusion under surgical stress conditions, compared with LR infusion. The dogs were infused with LR or LRD during surgery under halothane gas anesthesia. The results are shown in Fig. 1 and Tables 1, 2 and 3. Blood glucose level was elevated markedly with the infusion of LRD, and the values of the *LRD-10 group* and the *LRD-20 group* were 235.0±56.9 mg/d*l* and 456.7±118.2 mg/d*l*, respectively, 120 minutes after the initiation of LRD infusion. The values did not change in the *LR-20 group*. The NEFA levels in the *LRD-10 group* and the *LRD-20 group* decreased, and the latter was statistically significant in comparison with the value of the *LR-20 group* (Fig. 1). Changes of plasma Na and K

Table 3. Liver glycogen content

Group	Initial amount	Final amount	Amount increased g/100 g Liver	Percentage increased (%)
LRD-10 (n=4)[b]	0.395±0.318[a]	0.782±0.491	0.388±0.303	198.0
LRD-20 (n=8)	0.381±0.683	1.062±0.905	0.681±0.419*	278.7
LR-20 (n=4)	0.520±0.565	0.514±0.391	−0.006±0.260	98.8

a) Mean±SD.
b) Number of dogs.
* Significantly different from LR-20 group ($P<0.05$).

levels were not observed. Values of PP in all 3 groups decreased significantly with the infusion from their initial values. Plasma osmotic pressure of dogs infused with LRD showed a tendency of rising and dogs infused with LR showed a tendency of decreasing. However, there were no significant differences between the dogs administered with LRD and those with LR (Table 1). The urine volume of the *LRD-20 group* increased remarkably, but those of the *LRD-10 group* and the *LR-20 group* did not show any changes (Table 2). Urine glucose was detected in 2 out of 6 samples from the *LRD-10 group* and in all samples from the *LRD-20 group,* but was not detected from the samples of the *LR-20 group*. The content of liver glycogen of the *LR-20 group* was almost unchanged from the initial value, but those of the *LRD-10* and the *LRD-20 groups* increased clearly (Table 3).

DISCUSSION

There are very few papers on transfusion during surgery in veterinary medicine. Transfusion during surgery in small animals is performed using lactate Ringer solution (LR) in the same manner as in humans. Though LR is a selected supplement, based mainly upon concerns in circulating dynamics and sodium balance, glucose metabolism should also be considered, as it is affected greatly by surgical stress. This experiment was performed to see whether or not dextrose administration could prevent the release of NEFA and the decrease of liver glycogen, and if there are any side effects. The administration of free water should be avoided during or after surgery, since the secretion of antidiuretic hormone (ADH) is accelerated by surgical stress [2]. From these considerations, we used LRD, which is supplemented with 5% dextrose. The osmotic pressure of LRD is 2 times higher than that of LR.

As shown in Fig. 1, the blood glucose level in the dogs under halothane gas anesthesia and surgical stress was elevated remarkably by infusion with LRD at the rate of 10 ml/kg/hr or 20 ml/kg/hr, while the level in dogs infused with LR did not show any changes. It is well known that insulin excretion is restricted and the excretion of hormones which increase blood glucose is stimulated under surgical stress. This condition is called a diabetes-like state [10]. Schmidt *et al.* reported that increase of the blood cortisol level in dogs anesthetized with halothane was observed under surgical stress [9]. It is also known that cortisol restricts glucose tolerance and inhibits the lowering effect of insulin of blood glucose [8]. Glucocorticoids elevate blood glucose levels only when some factors which elevate blood glucose levels take effect in animals. From these considerations, the marked increase of glucose levels in the dogs of the *LRD-10* and the *LRD-20 groups* was probably due to the fact that the dogs were under

surgical stress conditions. However, excessive increase of blood glucose is undesirable. Thus attention must be paid to infusion with LRD in diabetic animals and animals administered with substances causing hyperglycemia such as xylazine.

The blood NEFA level in the dogs of the *LR-20 group* did not change, while those in the *LRD-10* and the *LRD-20 groups* decreased markedly and the latter was statistically significant from the value of the *LR-20 group*. The blood NEFA level is known to be increased by preoperative fasting and surgical stress, but halothane restricts the release of NEFA through the depression of sympatho adrenal activity [4]. This information probably supports why the NEFA level in the *LR-20 group* was not changed. However, it was clarified that the depression on the release of NEFA, caused by glucose administration, would develop even in dogs under a diabetes-like state. An increase of liver glycogen was observed in dogs administered with LRD, while no changes were seen in dogs administered with LR. This suggested a dextrose inhibited glycogenesis in the liver under surgical stress conditions.

It is suggested that a hypokalemia may develop by a movement of K^+ from the extracellular fluid to the intracellular fluid. Endogenous insulin is considered to be responsible for this, as a side effect, when dogs are administered with glucose. However, no changes of plasma K^+ were detected in this experiment. This result was thought to be affected by the lowered insulin excretion during surgery.

It is said that urine volume should be strictly in the range of 0.5–1.0 ml/kg/hr with sufficient transfusion during the operation [12]. Sufficient volume of urine was excreted when dogs were infused with 20 ml/kg/hr of LRD, while the volume excreted by dogs infused with LR or 10 ml/kg/hr of LRD was smaller than that of the former. It is considered that the result was due to the effect of osmotic diuresis caused by the addition of dextrose to LR [5]. The effect of osmotic diuresis was evident from the results which showed that the plasma osmotic pressure in dogs of the *LRD-20 group* tended to be elevated, while that the *LR-20 group* tended to be lowered, and that urine glucose was detected in dogs of the *LRD-10* and the *LRD-20 groups*. The administration of hypertonic solution to animals accelerates the secretion of ADH which concentrates their urine [7]. On the other hand, it is known that hypertonic glucose solutions do not stimulate the secretion of ADH [11].

From the above results, it was considered that a combination LRD should be used rather than L R alone, since the addition of adextrose to LR was demonstrated to cause favorable effects on dogs under surgical stress conditions.

REFERENCES

1. Anan, K. 1976. Polysaccharide. pp. 161–162. *In*: Basic Biochemical Experiment 5, Maruzen, Tokyo (in Japanese).
2. Goldberg, M. 1981. Hyponatremia. *Med. Clin. North Am.* 65: 251–269.
3. Graham, E. A. 1915. The resistance of pups to late chloroform poisoning in its relation to liver glycogen. *J. Exp. Med.* 21: 185–191.
4. Hashimoto, Y., Iwatsuki, K., and Takahashi, H. 1968. Changes of non-esterified fatty acid under general anesthesia. *Jpn. J. Anesthesiol.* 17: 101–102 (in Japanese).
5. Kitaoka, T., Akizawa, T., Takahashi, K., and Koshikawa, S. 1983. Osmotic diuresis. *Nihon Rinsho* 41: 1175–1188 (in Japanese).
6. Miletich, D. J., Albrecht, R. F., and Seals, G. 1978. Response to fasting and lipid infusion of epinephrine-induced arrhythmias during halothane anesthesia. *Anesthesiology* 48: 245–249.
7. Moses, A. M., and Streeten, D.H.P. 1967. Differentiation of polyuric states by measurement of responses to changes in plasma osmolality induced by hypertonic saline infusions. *Am. J. Med.* 42: 368–377.
8. Sakurai, T., and Hosoya, N. 1966. Metabolic regulation in diabetes mellitus. *Metabolism and*

Disease 3: 234–241 (in Japanese).
9. Schmidt, R. E., and Booker, J. L. 1982. Effects of different surgical stresses on hematologic and blood chemistry in dogs. *J. Am. Anim. Hosp. Assoc.* 18: 758–762.
10. Van Italli, T. B., and Bergen, S. S. Jr. 1960. Regulation of blood glucose altered dynamics in certain diabetes-like state. *Diabetes* 9: 286–291.
11. Verney, E. B. 1947. The antidiuretic hormone and the factors which determine its release. *Proc. Roy. Soc. Lond.* 135: 25–106.
12. Webb, A. I. 1982. Fluid therapy in hypotensive shock. *Vet. Clin. North Am.* 12: 515–531.

要　約

手術中の犬における乳酸リンゲル液とデキストロース加乳酸リンゲル液の輸液効果の比較：織間博光，川瀬清，一木彦三（日本獣医畜産大学獣医第二外科学教室）——ハロセン吸入麻酔下で手術を行った犬の手術中に乳酸リンゲル液（LR）とデキストロース加乳酸リンゲル液（LRD）を輸液し，前者を対照としてデキストロース添加の効果を検討し，以下の成績を得た。1)LRD 輸液は手術侵襲下の犬における NEFA の遊離を抑制した。2)LRD 輸液は手術侵襲下の犬の肝グリコーゲン量を増加させた。3)LRD 輸液によって手術侵襲下の犬における十分な尿排泄量が維持された。以上の成績から，手術中の LRD 輸液は LR 単独輸液より有用であると考えられた。