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HEMODYNAMIC EFFECTS OF EPIDURAL ANALGESIA FOR GASTRECTOMY IN THE GERIATRIC PATIENT

(epidural analgesia/hemodynamics/geriatric patient)

Yoshihiro KOSAKA, Kazuyuki MATSUI, Yuji NISHIO, and Kohya SHIIHARA

Department of Anesthesiology, Shimane Medical University, Izumo 693,

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The hemodynamic effect of epidural analgesia supplemented with a small dose of sedatives was studied by Swan-Ganz Catheter method in fifteen geriatric patients from 65 to 80 years old with gastrectomy. No premedication was given to avoid its circulatory effects. From one venous route 5 ml/kg/hr of lactated Ringer solution and from the other hydroxyethyl starch at the same rate were infused. Epidural puncture was performed in the intervertebral space between T_8 and T_{10} and 6 to 8 ml of 2% mepivacaine were administered through the epidural catheter. Analgesia by epidural block 20 min later was in average from T_2 to L_1. Hemodynamic parameters were assessed before, 20 min after epidural block, and 5 and 20 min after diazepam (5 mg). After 20 min of epidural analgesia, HR (-5%), MAP (-19%), SVR (-16%), and RPP (-28%) decreased significantly, while MPAP, CVP, CI, SVI and PVR did not change. Five minutes after diazepam, hemodynamic parameters decreased by 10% more. These changes, however, returned to the pre-administration level 20 min after diazepam. Though meticulous caution is needed for intraoperative management from a circulatory and respiratory standpoint, we consider epidural analgesia to be one of the recommendable anesthetic methods for the anesthesia of gastrectomy in elderly patients.

It is widely accepted that general anesthesia with endotracheal intubation is the first choice as an anesthetic method in upper abdominal surgeries. In geriatric patients who often suffer from weakened muscle strength and reflexes (vagal reflex) only 1.5 to 2.0 % of local anesthetics can sufficiently induce relaxation of abdominal musclature and we have discovered

that epidural analgesia enables gastrectomy to be done without general anesthesia. Epidural analgesia has been available especially for elderly patients for the purpose of intraoperative management as well as postoperative. One can take more advantage of this than is realised; epidural analgesia is worth recommending for anesthesia for gastrectomy in elderly patients depending on the cases being dealt with.

In our previous study we took epidural analgesia with light sedation for anesthesia of gastrectomy in elderly patients and examined its safety and some of its problems by analyzing arterial blood gases on various spots during anesthetic and operative procedures (1). It was concluded that epidural analgesia in itself did not exert an adverse effect on blood gas analysis but that intravenous administration of sedatives and analgesics for intraoperative sedation induced a temporary rise in $PaCO_2$, therefore, we pointed out that some caution is necessary in relation to the respiratory state of the patient after the administration of a small dose of sedatives. In this study we meticulously examined the hemodynamics by inserting a Swan-Ganz catheter into those elderly patients with epidural analgesia for gastrectomy.

MATERIALS AND METHODS

Fifteen patients from 65 to 80 years old with elective gastrectomy participated in this study. (Table I) They did not have any cardiovascular complications preoperatively; there were nine males and six females, the average age 70, height 156cm, and weight 51 kg. Informed consent was obtained from patients participating in the study.

No premedication was given to get rid of cardiovascular effects. In the operating room, after two venous infusion lines were obtained and left radial artery was inserted with a Teflon catheter, epidural puncture was performed in the intervertebral space between T_8 and T_{10} with an 18 gauge Tuohy needle in the left lateral position. (Fig. 1) Epidural space was identified by the hanging drop method. A 'Portex' epidural catheter was then inserted 5 cm in the rostal direction. A Swan-Ganz catheter was placed through the right internal jugular vein.

After a certain time of rest, arterial pressure (AP), pulmonary arterial pressure (PAP), pulmonary capillary wedge

Table I. DETAILS OF THE PATIENTS STUDIED

Patient		Age (yr)	Sex	HT (cm)	BW (kg)	Dose (ml)
1	M.O.	75	M	168	50	7
2	Y.M.	66	F	147	51	7
3	K.I.	65	F	140	36	6
4	A.H.	73	M	163	50	7
5	M.N.	75	F	156	46	6
6	Y.I.	70	F	146	44	6
7	S.F.	80	F	142	42	7
8	M.Y.	66	M	165	71	8
9	S.O.	65	M	161	48	8
10	T.H.	68	M	163	63	8
11	J.M.	70	M	153	40	8
12	T.O.	72	M	161	65	8
13	K.I.	69	F	156	55	7
14	K.K.	67	M	162	49	8
15	I.S.	65	M	156	60	9
n=15		70±4	M=9 F=6	156±9	51±10	7±1

Operation performed: gastrectomy
administered local anesthetic:
mepivacaine 2 %

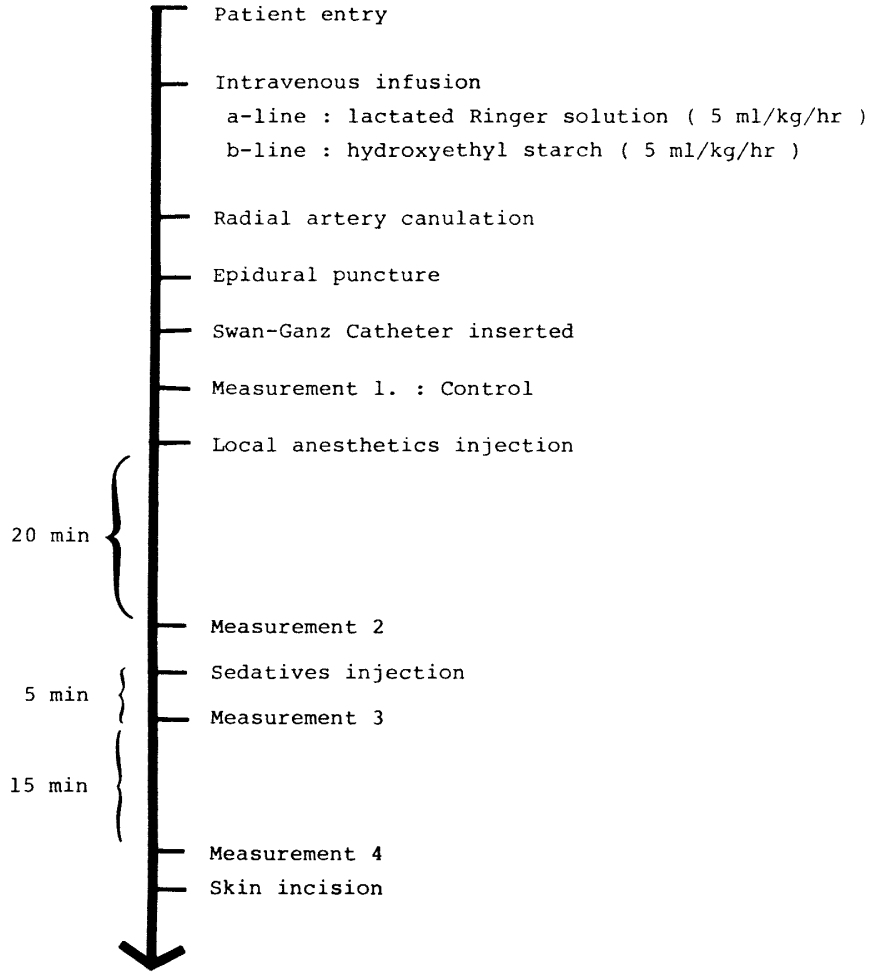

Fig. 1. Procedures of study

pressure (PCWP), heart rate (HR), and cardiac output (CO) were measured and recorded as control values. At the same time, blood samples from the pulmonary and the radial artery were obtained for gas analysis. 6 to 8 ml of 2 % mepivacaine were administered through the epidural catheter. In order to minimize the blood pressure lowering effect of epidural block, a comparatively large amount of fluid was infused from the beginning at the fixed rate. From one venous route, 5 ml/kg/hr of lactated Ringer solution and from the other HES (Hyroxyethyl starch) at the same rate were given simultaneously.

Twenty min after the local anesthetic was given through the epidural catheter, the above-mentioned hemodynamic paremeters were measured and recorded again. For the sake of intraoperative sedation, 5 mg of diazepam was administered intravenously. 3-5 min and 20 min after diazepam was given, the 3rd and 4th measurements of the various parameters were taken and then recorded. Cardiac output was calculated by an Edward laboratory 9520-A with the thermodilution method and pressure was measured by a Gould's P-50.

No patient was given oxygen throughout the study; all were allowed to breathe in room air. Drugs to deal with expected vasoactive effects were not necessary in the study. Student t-test was used to test statistical significance and $P<0.05$ was considered significant.

RESULTS

Analgesia by epidural block 20 min later was, an average, from T_2 to L_1 ($\pm$ one segment), which was assessed by the pin-prick method. Changes in hemodynamic parameters are summarized in Table II. MAP, MPAP, PCWP, HR, SVR, and RPP tended to decrease after epidural block but MAP, HR, SVR, and RPP were significant. Diazepam, 5 mg iv. reduced further these values, and their restoration to the control rates required 20 min. The percentage change in parameters was 88% in PCWP, 81% in MAP, 84% in SVR, and 72% in RPP, at 20 min after epidural block. Diazepam intensified the reducing tendency to 77% in PCWP, 70% in MAP, 75% in SVR, and 60% in RPP. It took 20 min for MAP, SVR and RPP to come back to the pre-administration level. During the study, CVP changed minimally and CI and stroke volume index (SVI) showed only a small change, within 10%.

Table II. SERIAL CHANGES IN VARIABLES AND PERCENT CHANGE

	n	Control	20 min after epidural	5 min after diazepam	20 min after diazepam
PCWP	15	11 ± 4	9 ± 4	8 ± 4*	10 ± 4
M PAP	15	17 ± 4	15 ± 5	15 ± 5	15 ± 5
M AP	15	118 ± 20	95 ± 23**	82 ± 17**	88 ± 19**
CVP	15	8 ± 3	8 ± 3	8 ± 3	8 ± 3
HR	15	72 ± 14	69 ± 13*	65 ± 11**	67 ± 13
CI	15	3.7 ± 0.7	3.5 ± 0.9	3.4 ± 0.7	3.5 ± 0.9
SVI	15	51 ± 10	53 ± 14	53 ± 10	53 ± 12
SVR	15	1700 ± 600	1500 ± 600**	1300 ± 500**	1400 ± 600**
PVR	10	120 ± 40	140 ± 50	140 ± 40	120 ± 50
RPP	15	12400 ± 3300	8900 ± 2900**	7300 ± 2100**	7900 ± 2600**
pH	15	7.40 ± 0.03	7.38 ± 0.02*	7.36 ± 0.02**	7.38 ± 0.03
PaO_2	7	71 ± 7	77 ± 9**	72 ± 6	81 ± 8**
$PaCO_2$	15	42 ± 5	44 ± 6	45 ± 6	44 ± 7
BE	15	1 ± 1.9	0.5 ± 2.2	0 ± 2.2	0.3 ± 2.6
SR	15	18 ± 8	16 ± 8*	18 ± 8	14 ± 8*

Statistical significance : **$<$P 0.01 and * P$<$0.05
data are expressed as mean ± S.D.

Abbreviations used are as follows :

PCWP	; pulmonary capillary wedge pressure	torr
MPAP	; mean pulmonary arterial pressure	torr
M AP	; mean arterial pressure	torr
CVP	; central venous pressure	cmH_2O
HR	; heart rate	beats/minute
CI	; cardiac index (cardiac output/BSA)	$l/min/m^2$
SVI	; stroke volume index	$(ml/beat/m^2)$ or ml
SVR	; systemic vascular resistance	$dynes \cdot sec \cdot cm^{-5}$
PVR	; pulmonary vascular resistance	$dynes \cdot sec \cdot cm^{-5}$
RPP	; rate pressure product	torr·beats/min
pH		
PaO_2		mmHg
$PaCO_2$		mmHg
BE		
SR	; intrapulmonary shunting rate	%

SR is derived by using Kelman and Nunn equation to obtain saturation rate (atm p; 760 torr, RQ; 0.8, Fio_2; 0.21 and BT; 37°C were presumed for the calculation.)

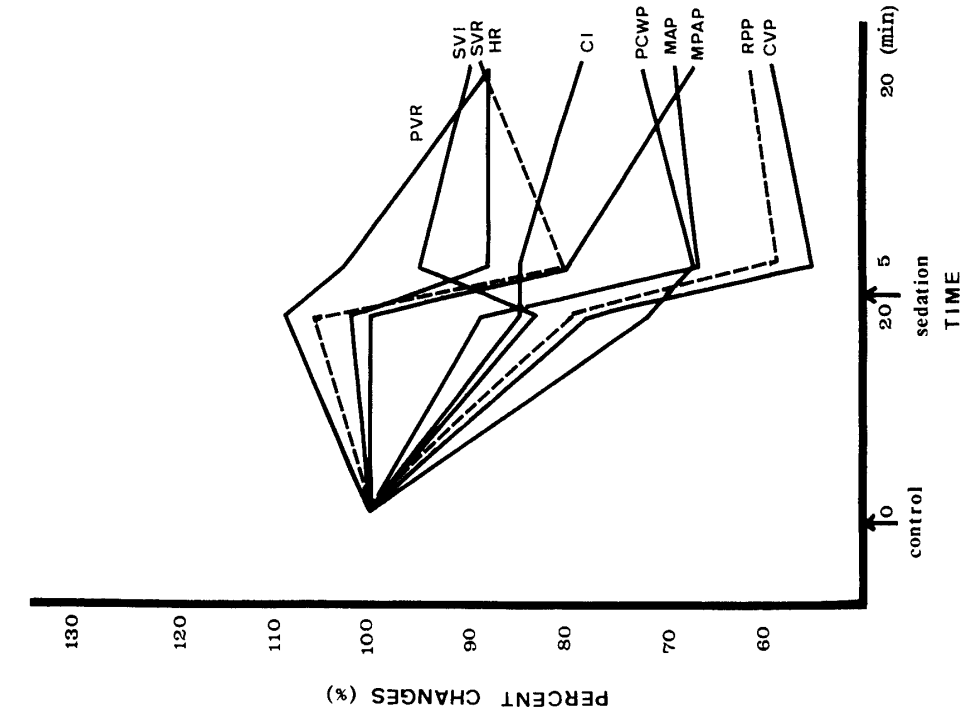

Fig. 3. Hemodynamic changes in Case 5

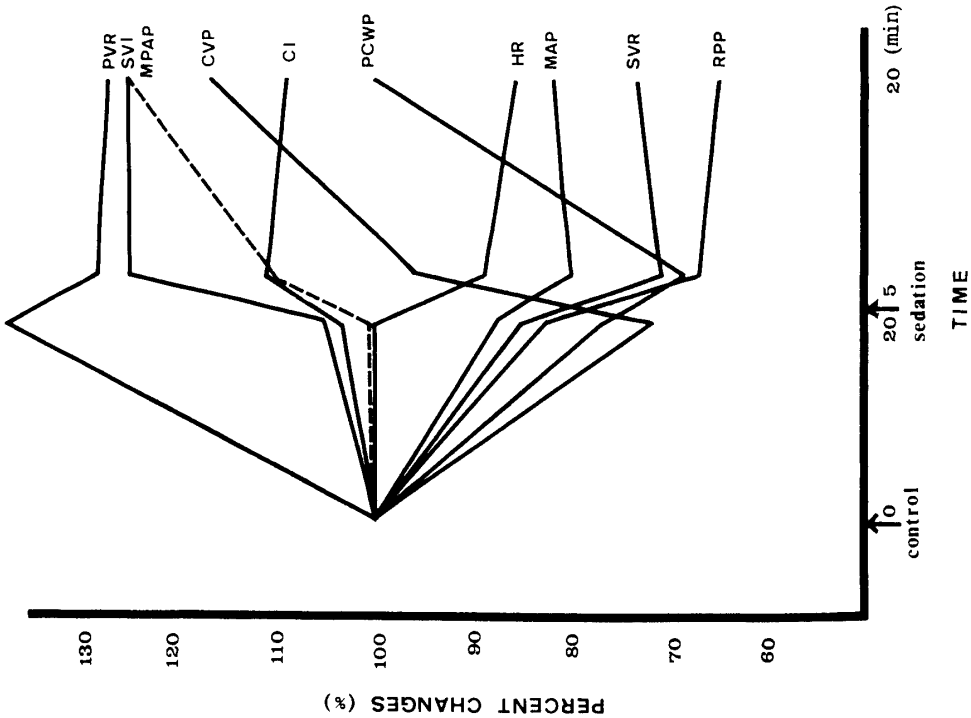

Fig. 2. Hemodynamic changes in Case 14

As for changes in respiratory parameters, PaO_2 slightly increased after epidural block, and intravenous diazepam caused a rise in $PaCO_2$ and a drop in pH. Intrapulmonary shunt also tended to decrease. These alterations in hemodynamic parameters presented individual variation from case to case. In case No. 14 (Fig. 2) only a slight change in the various values was seen with intravenous diazepam administration , but in case No.5 (Fig. 3) a considerable change occurred with the same drug injection. No patient had to be dropped out of the study owing to sudden blood pressure lowering and/or circulatory collapse.

DISCUSSION

If epidural analgesia with light sedation is adopted for the intraoperative management of upper abdominal surgeries, various problems can be anticipated: one is a sharp decrease in blood pressure due to extensive paralytic segments; another is respiratory depression due to the motor paralysis of intercostal respiratory muscles; the third is a decrease in heart rate and an influence on cardiac output due to the sympathetic nerve block, if extended beyond the T_4 level.

Cardiovascular responses to epidural block, like those to subarachnoid block, are believed to be due primarily to the effects on sympathetic nerves (2). Bromage (3) summarized this under five points: 1) dilatation of resistance and capacitance vessels; 2) paralysis of cardiac sympathetic fibers from the upper four thoracic segments resulting in bradycardia with reduction of cardiac output; 3) vascular absorption of local anesthetics, which causes a decrease in cardiac output owing to beta receptor blockade and peripheral vascular smooth muscle depression; 4) beta receptor stimulation owing to vascular absorption of epinephrine if present, increasing CO and decreasing TPR and 5) sudden elevation of cerebrospinal fluid pressure owing to peridural injection producing transient reflex increases in vasomotor tone and cardiac output. As we used plain mepivacaine and injected it very slowly through the epidural catheter, influences related to 4) and 5) above were eliminated in the present study. Bonica (2) and Bromage (4) demonstrated that when man is in normovolemia with normal cardiovascular compensatory mechanism, epidural block extending to the T_{4-5} is not usually associated with significant hypotension and decreased

cardiac output, and that its effect on blood gas analysis resulting from respiratory depression is very small.

Wahba et al. (5) concluded that a sensory block up to the 4th thoracic segment was not followed by any significant change in FRC, FEV 1.0, VC, A-aDO_2, Q_s/Q_t or cardiac output (5). But this is not the case with elderly patients or with hypovolemia. We have often experienced an exaggerated drop in blood pressure even with lumbar epidural block and have been concerned about how to treat it. In our study certain techniques were adopted in order to minimize blood pressure lowering so that it might not proceed to a circulatory collapse. No premedication was administered to avoid its circulatory effects and patients' hydration was profuse enough with 5 ml/kg/hr of lactated Ringer solution and the same rate of HES being infused constantly from the beginning of the procedures. Furthermore, we attempted to lessen the number of segments anesthetized especially the number of lumbar segments which affect the lower limbs, which have a large capacity of vessels, if completely dilated with block. We injected 2% mepivacaine, 6-8 ml, with the intention of obtaining a paralysed area from T_2 to L_1 not permitting blood to steal into the lower limbs.

The average analgesic area virtually obtained in 15 patients in 20 min was from T_2 to L_1 $\pm$1 segment and the volume requirement per one segment paralysis of 2% mepivacaine was 0.6-0.8 ml. At that instant, hemodynamic alterations were -19% in MAP, -5% in HR, -4% in CI, -12% in PCWP, -16% in SVR, -28% in RPP, and there was a slight increase in SVI, PVR, and CVP. Among these the most outstanding changes were the decreases in MAP and SVR. It is estimated that thoracic epidural block for these elderly patients with sufficient fluid supplementation did not precipitate an imminent hemodynamic depression to a clinically dangerous level, and that MAP and SVR were the main parameters which significantly moved. 5 mg of diazepam intravenously administered at this time reduced MAP and SVR by 11% and 9% respectively. In one case diazepam did not induce any further remarkable change, and in another similar case (No.5) with minimal hemodynamic alteration by epidural, this sedative drug did make blood pressure drop to a considerable degree. Diazepam has been clinically used because it has the following four properties (6): 1) it is a tranquilliser, 2) an anticonvulsant, 3) it produces amnesia and 4) it relaxes muscle. But we have observed great individual

variations in response to diazepam. Some patients showed a slight drop in blood pressure, and it is possible that the observed decreases in blood pressure were due, in part, to sedation (7). Though almost all authors are agreed that diazepam in clinical doses exerts no significant influence on the cardiovascular system (8,9), it is also reported that patients with complicating cardiovascular diseases are involved in the reduction of cardiac index and lowered systemic blood pressure (7), and , although rare, circulatory collapse by diazepam (10,11). It is considered that in elderly patients in a weekened state of various compensation, diazepam should be administered with appropriate discretion even though there is no complication through cardiovascular disease.

Dan et al. (12) reported on epidural analgesia for geriatric patients over 60 years old with upper abdominal surgeries. 2% mepivacaine, 10-14 ml, (the average = 12 ml) was epidually injected and the analgesic area acquired in 15 min was from T_3 to $L_4 \pm 1$ segment. The influence on both CI and blood pressure was considerably extensive: 75% of 44 patients presented markedly reduced CI (below 2.2) and required certain measures for the restoration of circulatory stability. They postulated that the early CI dropping cases below 2.2 were preoperatively water deficient or dehydrated ones.

In our study, patients were not premedicated: they were amply hydrated with the steady infusion of lactated Ringer, 5 ml/kg/hr, and HES, 5 ml/kg/hr, and besides, the volume of local anesthetics injected was 6-8 ml which was considered to be relatively small. These are the reasons why a decrease in blood pressure was comparatively mild and CI change was only -4% and did not reach -10% even with diazepam iv.

We previously reported the change in arterial blood gas analysis in the same situation, that is, epidural analgesia for elderly patients with gastrectomy. In the present study the values of blood gas analysis as respiratory parameters did not move so greatly with an epidural injection of the drug, which almost corresponds to the previous results, though PaO_2 increased a little in value problably influenced by the fact that there was no premedication. Diazepam administered, however, made CO_2 accumulate by some degrees, as in our previous report. Where we met a marked decrease in blood pressure caused by epidural block, we attempted to deal with that by administering a small dose of

ephedrine, which possesses both alph- and beta-adrenergic action, intravenously. Continuous dopamine drip has also been recommended recently for this purpose (12).

This time we observed and examined the precise hemodynamic change caused by epidural block in elderly patients with gastrectomy, in which we used the Swan-Ganz catheter as a measurement method. If epidural analgesia with light sedation is taken for an anesthetic choice for gastrectomy in elderly patients, there are some practical and important points to bear in mind: preoperative patient condition should be appropriately assessed, especially the state of hydration; be prepared for respiratory and/or circulatory decompensation which can occur when a large venous route has been acquired prior to epidural puncture; avoid too large a volume of local anesthetics injected into epidural space; and also avoid inadvertent administration of intravenous sedative drugs.

Though meticulous caution is needed for intraoperative management from a circulatory and respiratory standpoint, we consider epidural analgesia to be one of the recommendable anesthetic methods for the anesthesia of gastrectomy in elderly patients.

REFERENCES

1) Kosaka, Y., Matsui, K., Asano, M., Kawasaki, H., Moriwaki, K., Takasaki, M., and Akio, T. (1983) Effects of epidural analgesia for gastrectomy on blood gas in the geriatric patient. Shimane J. Med. Sci., 7, 26-34
2) Bonica, J.J. (1970) Circulatory effect of peridural block. Anesthesiology, 33, 619-626
3) Bromage, P.R. (1967) Physiology and pharmacology of epidural analgesia: a review. Anesthesiology, 28, 592-622
4) Bromage, P.R. (1978) Physiology. In: Epidural analgesia, chapter 10, pp.347-370, W.B. Saunders Co., Philadelphia
5) Wahba, W.M., Craig, D.B., Don, H.F., and Becklake, M.R. (1972) The cardio-respiratory effects of thoracic epidural anaesthesia. Can. Anaesth. Soc. J., 19, 8-19
6) Dundee, J.W. and Wyant, G.M. (1974) Tranquillisers. In: Intravenous anaesthesia, chapter 12, pp. 248-273, Churchill Livingstone Co., Edinburgh
7) Dalen, J.E., Evans, G.L., Banas, J.S., Brooks, H.L.,

Paraskos, J.A. and Dexter, L. (1969) The hemodynamic and respiratory effects of diazepam (Valium). Anesthesiology, 30, 259-263

8) Nutter, D.O., and Massumi, R.A. (1965) Diazepam in cardioversion. New Engl. J. Med., 273, 650-651

9) Stovner, J. and Endressen, R. (1966) Intravenous anaesthesia with diazepam. Proceedings of the 2nd European Congress of Anaesthesiology. Acta Anaesthesiol. Scand. (Suppl.), 24, 223-227

10) Rollason, W.N. (1968) Diazepam as an intravenous induction agent for general anaesthesia. In: Diazepam in Anaesthesia, (Knight P.F. and Burgess C.G. eds.) pp. 70-73, Wright, Bristol.

11) Barrett, J.S. and Hey, E.B. (1970) Ventricular arrhythmias associated with the use of diazepam for cardioversion. JAMA, 214, 1323-1324

12) Dan, K. (1982) Epidural block. Nippon Rinsho Masui Gakkaishi. 2, 1-9 (in Japanese)