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Hemodynamic Changes and Plasma Catecholamine Level under Total Spinal Anesthesia in Two Cases.

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abstract

There are few reports of hemodynamic changes during total spinal anesthesia (TSA), although TSA has been used for treatment of a whiplash injury, or for management of general anesthesia. We evaluated the hemodynamics and blood concentrations of catecholamine in two cases managed with TSA.

In the first case (the resection of pheochromocytoma), the establishment of TSA did not alter the heart rate (HR), mean blood pressure (mAP) and cardiac output (CO). However, only by the manipulation of the tumor 75 minutes after TSA, these remarkably increased, and after ligation of the adrenal vein returned to the normal level (80 minutes later). In the second case (the resection of non-functional adrenal adenoma), HR, mAP and CO were gradually decreased, and became the lowest 110 minutes after TSA, then returnd to the pre-anesthesia level at the end of the surgery (70 minutes later).

Remarkable increases in epinephrine (Ep) and norepinephrine (NE) were observed at and after the time of tumor manipulation in the first case, and a slight increase in NE after tumor manipulation in the second case.

We conclude that TSA is stress-free anesthesia and may contribute to anesthesia management in some cases as reported.

Key words : Total spinal anesthesia, Hemodynamics, Plasma catecholamine concentration.

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Introduction

Evans[1] reported that total spinal anesthesia (TSA) has been found to provide excellent operating condition for abdominal surgery[1] and hemodynamic changes were slight during TSA than during high spinal anesthesia. But serum concentrations of catecholamine and local anesthetics were not investigated.

In this study, we observed the hemodynamic changes together with plasma lidocaine and catecholamine concentrations under TSA used as a method of general anesthesia.

Patients and Method

The protocol of the study was explained to each patient and the written informed consent was obtained.

The first case was a 36-year-old woman, whose ectopic pheochromocytoma in the urinary bladder was extirpated, and the second case was a 68-year-old woman who underwent the removal of nonfunctional adrenal adenoma. Both cases were complicated because of severe and uncontrollable hypertension resisted to medical treatment, with Ca antagonist, ACE antagonist and beta blocker prior to surgery.

As the premedication, atropine 0.5mg and diazepam 0.2mg/kg were given intramusculaly half an hour before induction. Before induction of anesthesia, ECG monitoring was started, a 20G catheter for the measurement of arterial pressure was inserted into the radial artery and a 7.5 Fr Swan-Ganz catheter was

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inserted into the pulumonary artery through the right internal jugular vein.

After the control measurement of hemodynamics, a polyechyiene catheter (1.0mm diameter) was inserted into the subarachnoid space 20cm cephalad through the 4th and 5th lumbar interspace. TSA was achieved by injection of 1% lidocaine 40ml through the catheter. After lidocaine injection, the trachea was intubated using intravenous thiamylal 50mg together with vecuronium 0.08mg/kg after patients became drowsy and their respiration was suppressed. We were confirmed the establishment of TSA by loss of consciousness, respiratory depression and loss of brain stem reflex. Ventilation was mecanically supported with oxygen and nitrous-oxide (O_2 2L/min: N_2O 4L/min). Hemodynamics, blood gas (arterial & mixed venous), and lidocaine and catecholamine concentrations of arterial blood were measured before induction of TSA, 5 min before skin incision, at the time of tumor manipulation and ligation of the adrenal vein, and 5 min after the resection of the tumor. Measured and calculated hemodynamic values were heart rate (HR), mean arterial pressure (mAP), cardiac output (CO), pulmonary capillaly wedge pressure (PCWP), and systemic vascular resistant (SVR).

Blood lidocaine and catecholamine concentrations were measured by high performamce chromatography.

A single regression analysis was used for the statistical analysis and $p<0.05$ was regarded significant.

Results

Changes in hemodynamics, and serum catecholamine and lidocaine concentrations under TSA are presented in Table 1.

In the first case (pheochromocytoma), TSA did not change mAP, decreased CO, and increased HR and SVR. HR, mAP and CO remarkably increased by the manipulation of the tumor, but SVR was unchanged. The gradual decrease in SVR was observed after the removal of the tumor and at the end of surgery SVR decreased to 45% of the pre-TSA value. A significant increase in plasma norepinephrine concentration (14 times of the start) was only observed at the time of tumor manipulation in the first case.

In the second case (nonfunctionl adenoma), HR, mAP and CO were gradually decreased after TSA, and became the lowest at the time of manipulation of the tumor. There was no remarkable change in SVR after TSA, as well as through surgery. Plasma epinephrine concentration did not alter, while norepinephrine slightly but significantly increased at the time of manipulation of the tumor, ligation of the adrenal vein and the end of surgery.

In the case of pheochromocytoma, the changes in CO closely correlated to those of PCWP ($R=0.63$, $n=9$, $p<0.05$), while the relationship was not revealed in the case of adrenal adenoma. The correlation between CO and HR and between CO and mAP were present in the case of adrenal adenoma, ($R=0.89$, $n=7$, $p<0.05$ & $R=0.71$, $n=8$, $p<0.05$), but in the case of pheochromocytoma were not. The changes in SVR were correlated to those in mAP in case of pheochromocytoma ($R=0.9$, $n=9$, $p<0.05$), but not in the case of adrenal adenoma.

Blood lidocaine concentration did not exceed the toxic level throughout TSA in both cases.

Discussion

Evans[1] reported that the total spinal anesthesia (TSA) when used on critical anesthesia showed few hemodynamic changes. Tumura et al[2] successfully used TSA for the treatment on patients of whiplash injury whose symptoms were severe enough not to be responded to the conservative treatment. Shibuya et al[3] reported that TSA could stabilize hemodynamic disturbance when used for the management of severe tetanus.

We hypothesized that the denervated vasucular bed may not be responded to catecholamine during resection of pheochromocytoma, and then TSA was selected in the first case. In the case of nonfunctional adrenal adenoma, blood catecholamine concentrations did not show any considerable changes, and correlations between of changes in CO and HR, and between CO and mAP were presented. SVR did not show any considerable changes. Since the cardiovascular system was denervated by TSA, and free from the influence of

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Table 1. Hemodynamic data and catecholamine concentration

		Pre induction	after induction	tumor manipulate	resection of tumor	ligation of vein	end of operation
HR (bpm)	pheo	75	98	163	96	119	95
	non	65	63	43	48	46	56
m-AP (mmHg)	pheo	96	97	218	81	57	64
	non	105	82	55	66	80	114
CO (L/min)	pheo	6.34	4.73	11.85	5.31	5.39	7.80
	non	5.84	4.29	2.49	4.63	3.70	4.54
PCWP (mmHg)	pheo	1	4	38	8	0	9
	non	0	1	−1	0	−1	−2
SVR (dyne/sec/cm-5)	pheo	1236	1606	1404	1190	831	553
	non	1424	1510	1670	1036	1531	1913
Epinephrine (ng/ml)	pheo	0.05	0.01	0.25	1.07	1.18	0.64
	non	0.02	0.01	0.01	0.91	1.11	0.01
Norepinephrine (ng/ml)	pheo	1.64	1.4	22.9	7.82	3.14	4.22
	non	0.05	0.01	0.25	1.07	1.18	0.64
Blood lidocaine concentration (μg/ml)	pheo		6.0	6.0	3.6	2.9	2.0
	non		3.8	4.9	3.2	2.8	1.6

pheo : pheochromocytoma

non : non functional adrenal adenoma

▒▒▒ : indicate slightly or remarkably increasing values.

circulatory catecholamines, changes in mAP seem to be dependend on changes in CO and HR. On the other hand, during the manipulation of pheochromocytoma, the blood catecholamine concentration was strikingly increased. This increase in circulating catecholamine induc venoconstriction, thus increases venous return by centralization of circulating blood, which expresed as increase in PCWP in this case, namely increase in the preload of the heart. The increase in CO of this case may, therefore, be explained by the increase in the preload, according to "Starling's law of the heart". The increase in circulating catecholamines may also accelerate cardiac contractility to increase CO. The striking elevation of mAP is contributed by the increased CO. In the second case, after the tumor manipulation, CO decreased from 5.84 L/min to 2.49 L/min, and cardiovascular system was considerd to be remarkably depressed.

Results obtained in our study suggested that cardiovascular depression was originated from the decrease in venous return by venodilatation, and from the decreasing of heart rate and cardiac contractility by sympathetic nerve blockade. Increased SVR (calculated value) may be due to decreased CO (measured value). But Kobori et al[4] reported that myocardial oxygen demand and supply were are well balanced under total spinal anesthesia.

Considering the blood catecholamine concentration in the first case, the value was not influenced by the operative invasion, although tumor manipulation increased it. Accordingly, we speculated that the patient under TSA was in a stress-free condition. Moreover,

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since the remarkable increase in norepinephrine by the manipulation of pheochromocytoma did not change SVR, the ability of resistance vessel responding to curculating catecholamine is suggested to be diminished by TSA-mediated denervation. However, the responsiveness of the heart to circulating catecholamines is surely preserved under TSA.

In this study, blood lidocaine concentrations were always under the toxic level, however there has been a report demonstrating that the blood concentration of the local anesthetics reaches to the toxic level after TSA[5]. Further investigation should be needed on the injection site and the volume of lidocaine.

One of the disadvantages of this technique is the finite duration of anesthesia. Tada et al [6] reported that electroencephalogram may be a good tool to evaluate the anesthetic depth during TSA.

According to changes in the blood catecholamine concentration, we conclude that total spinal anesthesia is "stress-free anesthesia", and contributes to maintain a good operative condition.

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