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Evaluation of Hemodynamics During Posture Change to Knee-Chest Position by FloTrac™

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Summary : In order to evaluate changes in hemodynamics, a FloTrac™ system was used during posture change from supine to knee-chest position. Thirty-five patients undergoing lumbar surgery participated in this study. Anesthesia was performed with total intravenous anesthesia using propofol and remifentanil. Cardiac index (CI), stroke volume index (SVI), and stroke volume variation (SVV) were measured by using FloTrac™ in addition with heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean blood pressure (MBP). The values before and after postural change were compared. SVV increased immediately after posture change and remained high. With posture change to the knee-chest position, HR, DBP and SVV increased and SBP, CI and SVI decreased. An increase in SVV from immediately after postural change indicated that SVV did not reflect circulating blood volume.
Key words : FloTrac™, knee-chest position, postural change, total intravenous anesthesia

The spine surgery is performed in the prone position. It is known that increase of the intra-abdominal pressure is caused by pressing the abdomen, by which the increased pressure is transmitted to the epidural venous plexus in the prone position. As a result, blood loss will be increased in the prone position.[1)] To avoid the pressure to the abdomen, various type of prone positions were invented by using special operating tables and frames, such as Mohammedan praying position,[2)] modification type of the Tuck position,[3)] which have the feature of bending the thighs and the knees. Since the body weight was mainly supported by chest and knees, the pressure of the abdomen can be decreased. While knee-chest position has the advantage of decrease of abdominal pressure, we often experience in anesthetized patients whose blood pressure decrease by postural changes to the knee-chest position from the supine position.

The variation of hemodynamics with postural changes from supine to prone have been evaluated by various methods.[4–8)] However, there is no report to which the evaluation of hemodynamics by changing position from supine position to knee-chest position by using FloTrac™. In this study, we evaluated hemodynamics during the postural change by using FloTrac™ in patients with lumber spine surgery.

Materials and Methods

This study was approved by the ethical committee of Asa city hospital, and written informed consent was obtained from each patient. From April 2010 to March 2011, the subjects of the study were adults graded as American Society of Anesthesiologists physical status 1 or 2 who were planned to be operated on the lumber spine surgery in the knee-chest position according to Mohammedan praying position. Patents with known diabetic neuropathy, uncontrolled hypertension, obesity more than 30 of body mass index and cardiac disease such as atrial fibrillation and aortic regurgitation were excluded.

Anesthetic management protocol

General anesthesia was induced with remifentanil 0.2–0.5 μg/kg/min, target controlled infusion (TCI) system (TCI pump TE-371, Terumo Corporation, Japan) of propofol 2.0–3.0 μg/ml, and rocuronium 0.6 mg/kg intravenously, and was maintained with remifentanil 0.2–0.3 μg/kg/min. TCI system of propofol was used to keep concentration within 1.5–2.5 μg/ml. We used Entropy sensor™ system (GE Healthcare, Finland, Helsinki) and kept the response entropy and the state entropy within the range of 40 to 60.

After endotracheal intubation, ventilation was controlled mechanically at 8–10 ml/kg of tidal volume and 10–12 /min

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of respiratory rate to maintain end-tidal carbon dioxide in the range of 30 to 40 mmHg using capnography. Tidal volume and respiratory rate were not changed during postural change. Postural change was performed 10 minutes after endotracheal intubation. Acetated Ringer's solution was given at the rate of 10 ml/kg/hour during the study period.

Monitoring

A 22-gauge catheter was inserted into left radial artery during anesthetic induction, and CI, stroke volume index (SVI), stroke volume variation (SVV) were measured using a FloTrac™ system (Edwards Lifesciences, Irvine, CA, USA) and analyzed by the Version.3.02 of Vigileo™ monitor (Edwards Lifesciences, Irvine, CA, USA). Heart rate (HR) and direct measurement of arterial pressure of systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean blood pressure (MBP) were also measured.

Statistical analysis

We measured each value at before postural change and at 3, 5, and 10 minutes after postural change. The values were analyzed by Analysis of variance (ANOVA), and post-hoc test was by Fisher's PLSD. A p-value less than 0.05 were considered to be statistically significant.

Results

Thirty-five patients were participated in this study. The patient's backgrounds are shown in Table 1. The sequential values obtained at each time in HR, SBP, DBP, MBP, CI, SVI, and SVV are shown in Table 2.

Discussion

There are several reports on hemodynamics associated with postural change.[4–8] The most universal finding is decreases in CI. This is considered to be decrease in the left ventricular compliance. Increase in the intrathoracic pressure depresses the venous return according to increased intra-abdominal pressure, and the decrease in venous return is produced because position of the extremities were placed lower than the heart.[4] The same mechanisms of hemodynamics are predicted in the postural change of the knee-chest position. However, the hemodynamic changes are probably emphasized in the knee-chest position because the limbs placed lower compared with that of prone position. It is reported that the central venous pressure of the knee-chest position is lower than that of the prone position, and this difference is attributable to the position of the lower limb.[7]

In this study, we evaluated the hemodynamic changes of the postural change to the knee-chest position from the supine position by using a FloTrac™ system. In the results of our study, HR, DBP and SVV increased, and SBP, CI and SVI decreased after postural change. We considered that these changes were caused by activated sympathetic nervous system and inhibited parasympathetic activity.[9] It was also considered that these autonomic nerve reactions took place as the venous return decreased due to postural changes. However, in the previous reports the increase of HR does not occur in postural changes to the prone position.[4,5,8] In the knee-chest position, the extremities are placed lower than in the prone position, and changes in hemodynamics are probably emphasized. In the prone

Table. 1

The patient's backgrounds	
Number of patients	35
Surgery	
Lumbar disc hernia	7
Lumbar canal stenosis	28
ASA PS Class 1 : 2	8 : 27
Age (years)	65.3 ± 13.1
Gender man : woman	21 : 14
Height (cm)	159 ± 9.9
Weight (kg)	60.7 ± 9.6
BMI (kg/m^2)	23.7 ± 3.0

Mean ± SD

Table. 2

	Before the postural change	After the postural change			
		3 min	5 min	7 min	10 min
HR (beats/min)	71.8 ± 13.6	78.2 ± 14.1*	78.0 ± 14.0*	75.3 ± 12.4*	73.3 ± 11.8
SBP (mmHg)	115.8 ± 22.8	111.8 ± 23.1	101.9 ± 21.1*	96.0 ± 16.7*	93.2 ± 14.3*
DBP (mmHg)	53.6 ± 11.7	59.6 ± 11.4*	56.8 ± 9.8*	55.1 ± 8.8	54.2 ± 8.4
MBP (mmHg)	74.3 ± 13.8	77.0 ± 13.7	71.9 ± 12.6	68.7 ± 10.5*	67.2 ± 9.8*
CI (L/min/m^2)	2.6 ± 0.5	2.5 ± 0.6	2.2 ± 0.5*	2.1 ± 0.5*	2.0 ± 0.3*
SVI (ml/m^2)	35.9 ± 8.2	32.0 ± 6.9*	28.4 ± 6.1*	26.6 ± 5.3*	27.4 ± 4.5*
SVV (%)	13.4 ± 5.8	21.2 ± 6.5*	20.9 ± 6.7*	19.7 ± 5.8*	17.9 ± 4.9*

Note: Values are given as means ± SD (n = 35)
*$p < 0.05$ vs. Before the postural change

position, it is reported that the decrease of CI are caused by the decrease in venous return and the decrease in left ventricular compliance due to increased pleural pressure.[1)] Similar mechanism seems to be produced in the postural change of the knee-chest position.

In this study, CI decreased with postural change. Even though CI decreased and SVV increased, SVI did not change immediately after postural change. This seemed be due to SVV not only reflecting changes in the circulating blood volume at the knee chest position. An increase in intrathoracic pressure would be considered as one of the reasons of increases in SVV. In the prone position, it is reported that SVV is able to predict fluid responsiveness in prone during spine surgery.[8)] Because the influence of postural change was apparent in the knee-chest position than that in prone position, the response threshold of SVV for infusion seemed to be higher.

With posture change to the knee-chest position, HR, DBP and SVV increased and SBP, CI and SVI decreased. An increase in SVV from immediately after postural change indicated that SVV seemed to be not reflecting only circulating blood volume.

The abstract was presented at annual meeting of 57th Japanese society of anesthesiologists.

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