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Short communication

Central venous oxygen saturation accurately reflects mixed venous oxygen saturation during laparotomy

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Although measurement of mixed venous oxygen saturation ($S\bar{v}O_2$) is a common practice in the perioperative period in critically ill patients, this information can be obtained only via a pulmonary artery (PA) catheter. Insertion of the PA catheter is not free of risks and is associated with complications [1]. On the other hand, central venous catheters are commonly used with minimal risk. Previous studies have shown a good correlation between central venous saturation ($ScvO_2$) and $S\bar{v}O_2$ in the critically ill [2–5]. However, to our knowledge, comparative measurements of $ScvO_2$ and $S\bar{v}O_2$ during laparotomy have not been carried out. The aim of this study was to compare the oxygen saturation in the superior vena cava and pulmonary arterial blood samples before and during laparotomy.

The protocol of this study was approved by our ethics committee, and informed consent was obtained from each patient. We studied 25 adult patients of ASA physical status I or II who had been scheduled for hepatectomy. Central venous catheters were inserted through a subclavian vein a few days before the surgery. Chest X-rays revealed that the tip of the catheter was placed at the lower end of the superior vena ceva in all patients.

In the operating room, general anesthesia was induced with intravenous thiamylal and vecuronium and was maintained with isoflurane and nitrous oxide in oxygen. A 7.0F thermodilution flow-directed PA catheter (Baxter Health Care, Irvine, CA, USA) was placed through the right internal jugular vein while monitoring the pressure wave.

Simultaneous blood samples were taken from the distal lumen of the pulmonary artery catheter and central venous catheter just before and 2 h after the start of the surgery. Oxygen saturation was measured immediately after withdrawal in a Corning 2500 Co-Oximeter (Ciba-Corning, Tokyo, Japan). Cardiac output was measured using a standard thermodilution technique at the time of blood sampling. Data were analyzed using linear regression analysis and Student's unpaired *t*-test. A P value of less than 0.05 was considered statistically significant.

The results are summarized in Table 1. There was no significant difference between the mean values of $ScvO_2$ and $S\bar{v}O_2$ both before and during surgery. A highly positive correlation was found between $ScvO_2$ (x) and $S\bar{v}O_2$ (y) before surgery, $y = 0.763x + 9.6$; $r = 0.864$; $P < 0.01$. During surgery as well, a highly positive correlation was noted between $ScvO_2$ (x) and $S\bar{v}O_2$ (y), $y = 0.922x + 7.0$; $r = 0.8885$; $P < 0.01$. Mean cardiac output during surgery was significantly greater than before surgery ($P < 0.05$).

The current clinical study demonstrated that $ScvO_2$ is an accurate reflection of $S\bar{v}O_2$ during laparotomy. This finding could be attributed to the minimal effect of laparotomy on the correlation between $ScvO_2$ and $S\bar{v}O_2$. It has been reported that the blood flow to the splanchnic region is decreased significantly during laparotomy [6]. This change might result in the reduction of inferior vena caval saturation. Because inferior vena caval saturation is slightly higher than $S\bar{v}O_2$ due to the highly saturated renal venous effluent [2,3], the reduction of saturation might have little influence on the discrepancy between $ScvO_2$ and $S\bar{v}O_2$.

In this study, $S\bar{v}O_2$ was maintained at more than 60%. Thus, the question arises whether there is a good correlation between $S\bar{v}O_2$ and $ScvO_2$ if $S\bar{v}O_2$ decreases to less

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Table 1. Correlation between pulmonary arterial and superior vena caval oxyhemoglobin saturation and cardiac output before and during surgery

	Before surgery	During surgery
n	25	25
$S\bar{v}O_2$ (%)	83.4 ± 4.3 (71.6–89.4)	82.0 ± 6.9 (63.1–90.4)
$ScvO_2$ (%)	83.5 ± 4.6 (70.0–89.0)	82.9 ± 6.5 (62.6–89.1)
ScO_2-$S\bar{v}O_2$ (%)	−0.138 ± 2.6 (1.0–5.0)	0.587 ± 3.5 (0.3–5.4)
r	0.864	0.885
Cardiac output (l/min)	5.45 ± 1.27 (3.5–8.6)	6.33 ± 1.30 (4.5–9.4)*

Values are mean ± SD (range).
* $P < 0.05$ vs before surgery.
$S\bar{v}O_2$, mixed venous oxygen saturation; $ScvO_2$, central venous saturation; *r*, Pearson's correlation coefficient.

than 60%. $S\bar{v}O_2$ is determined by cardiac output, arterial oxygen content, and tissue oxygen consumption. Tissue oxygen consumption is considered to remain constant during general anesthesia. Berridge reported that the influence of cardiac output on the correlation between $ScvO_2$ and $S\bar{v}O_2$ is minimal in critically ill patients [5]. Therefore, when arterial oxygen content is maintained normally, the $ScvO_2$ value might be reliable even if $S\bar{v}O_2$ is lower.

It may be concluded that central venous sampling during laparotomy can be utilized in the estimation of $S\bar{v}O_2$.

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