The new transpulmonary thermodilution measurement to assess hemodynamic changes in patients undergoing open abdominal cytoreductive surgery with hyperthermic intraperitoneal chemotherapy (HIPEC): A prospective observational study

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Background

- ❖ Current treatments of peritoneal cancer combine cytoreductive surgery with **hyperthermic intraperitoneal chemoperfusion (HIPEC)**.
- ❖ Optimal anesthetic management of patients treated with this surgery requires control of a complex interplay of physiologic mechanisms.
- ❖ The loss and shifting of fluid during cytoreductive surgery with HIPEC were an important issue.
- ❖ We aimed to investigate the intraoperative physiologic changes including extravascular lung water of patients undergoing cytoreductive surgery with hyperthermic intraperitoneal chemotherapy in the department of colorectal surgery.

Method

- ❖ In this prospective observational study, among 31 patients who underwent cytoreductive surgery with HIPEC, a total of **21 patients** were enrolled.
- ❖ We applied the **volume view system** to all patients; An internal jugular vein and a femoral artery access were required to monitor hemodynamic parameters. These reflected the patient's respiratory, cardiovascular and intravascular volume states, which were monitored by an EV1000 monitor and blood gas analysis.
- ❖ We recorded and analyzed 7 time points (T1~T7) at immediately before skin incision, at 30 minutes before HIPEC, at 30 minutes, 60 minutes and 90 minutes after HIPEC, at 30 minutes after the end of HIPEC, and at 10 minutes before the end of surgery.

Results

Table 1-1.

Intraoperative hemodynamic parameters							
	T1	T2	T3	T4	T5	T6	T7
BT (℃)	36.3 (0.6)	35.7 (0.9)	36.9 (0.9)	37.7 (0.7)	38.0 (0.7)	37.5 (0.7)	36.8 (0.5)
HR (beat/min)	66.1 (12.3)	77.8 (14.7)	83.6 (14.4)	89.4 (16.6)	94.6 (17.6)	87.9 (17.4)	85.9 (15.1)
MBP (mmHg)	78.4 (11.0)	82.9 (9.9)	77.5 (8.4)	76.4 (6.9)	75.5 (7.0)	78.1 (7.5)	76.9 (7.9)
CVP (mmHg)	7.8 (3.2)	7 (2.8)	8.5 (3.0)	8.7 (3.2)	9.2 (3.4)	8.5 (3.7)	9.0 (3.2)
Volume view							
CI (L/min/m ²)	3.0 (0.7)	3.2 (0.8)	3.3 (0.8)	3.5 (0.8)	3.8 (1.1)	3.5 (1.0)	3.3 (0.8)
SVI (ml/beat/m ²)	43.3 (6.3)	47.2 (9.5)	49.7 (11.0)	35.0 (10.0)	50.2 (10.7)	49.6 (10.1)	46.2 (7.3)
SVV (%)	7.9 (4.2)	10.5 (3.7)	9.6 (4.2)	11.0 (4.7)	10.1 (3.9)	11.4 (6.2)	11.2 (5.1)
SVRI (dyn·s/cm ⁵ /m ²)	2327.1 (351.2)	1615.5 (252.0)	1623.5 (399.1)	1326.8 (434.8)	1362.9 (278.0)	1389.2 (293.4)	1467.4 (351.5)
ELWI (ml/kg)	6.9 (0.6)	6.9 (0.5)	7.1 (0.5)	7.1 (0.4)	7.3 (0.4)	7.1 (0.7)	6.9 (0.4)
PVPI	2.0 (0.4)	2.1 (0.4)	2.4 (0.4)	2.5 (0.5)	2.6 (0.4)	2.4 (0.6)	2.3 (0.4)

Values are the mean (SD). SD; standard deviation
BT, body temperature; HR, heart rate; MBP, mean arterial pressure; CVP, central venous pressure; CI, cardiac index; SVI, stroke volume index; SVV, stroke volume variation; SVRI, systemic vascular resistance index; ELWI, extravascular lung water index; PVPI, pulmonary vascular permeability index

Table 1-2.

	T1	T2	T3	T4	T5	T6	T7
ABGA							
PO ₂ (mmHg)	187.7 (30.0)	200.5 (34.4)	202.8 (26.3)	188.4 (28.2)	184.3 (29.1)	187.2 (25.5)	196.1 (21.6)
PCO ₂ (mmHg)	33.4 (4.6)	34.8 (3.7)	34.0 (5.2)	34.2 (4.0)	34.2 (3.4)	33.3 (3.1)	33.1 (3.8)
Hct (%)	11.4 (1.4)	10.7 (1.3)	10.8 (1.1)	10.9 (1.2)	10.7 (1.1)	10.6 (1.1)	11.0 (1.0)
pH	7.44 (0.03)	7.39 (0.04)	7.39 (0.04)	7.39 (0.04)	7.40 (0.04)	7.40 (0.04)	7.40 (0.04)
HCO ₃ (mmol/L)	22.8 (2.2)	21.2 (1.7)	20.6 (2.6)	21.0 (1.7)	21.0 (1.7)	20.5 (1.8)	20.3 (1.7)
Lactate (mmol/L)	0.9 (0.3)	1.5 (0.7)	2.2 (0.9)	2.9 (1.2)	3.3 (1.4)	3.5 (1.6)	3.1 (1.8)
Glucose (mg/dl)	88.5 (31.5)	134.0 (31.4)	185.9 (58.0)	215.2 (44.0)	207.2 (35.3)	189.4 (35.3)	160.1 (26.8)
Sodium (mmol/L)	137.0 (2.9)	136.1 (2.5)	135.5 (3.2)	134.5 (2.1)	135.0 (2.3)	134.9 (2.7)	135.7 (2.9)

Values are the mean (SD). SD; standard deviation
ABGA, arterial blood gas analysis; PO₂, partial pressure of oxygen; PCO₂, partial pressure of carbon dioxide; Hct, hematocrit; HCO₃, hydro bicarbonate

Table 2.

Intraoperative parameters	
Surgical time (min)	638.8 (207.8)
Anesthetic time (min)	718.1 (207.8)
Input	
Crystalloid (ml)	6983.3 (4496.4)
Hydroxyethyl starch 6% (ml)	976.2 (460.3)
packedRBC (ml)	207.1 (378.2, 0-1400)
Fresh Frozen Plasma (ml)	71.4 (181.4, 0-600)
Albumin (ml)	109.5 (151.3, 0-500)
Output	
Urine output (ml)	1464.8 (898.0)
Estimated blood loss (ml)	780.0 (928.6, 50-3350)
Rapid insulin (unit)	6.8 (4.3)

Values are the mean (SD). SD; standard deviation
RBC, red blood cell

Table 3.

Postoperative recovery profiles	
Coagulation profiles	
Pre-Op. platelet (/μl)	307,048 (127,403)
Post-Op. platelet (/μl)	238,952 (104,884)
Pre-Op. INR (%)	94.4 (8.4)
Post-Op. INR (%)	76.0 (14.4)
Acute kidney injury	1 (4.8%)
Respiration	
Extubation in ICU	9 (42.9%)
Post-Op. extubation (time)	9.9 (26.7, 0-124)
Bowel movement	
SOW (time)	66.3 (29.7)
GPT (time)	144.8 (115.5)
SDT (time)	129.5 (117.3)
Hospital stay	
ICU admission	17 (81%)
ICU LOS (day)	1.4 (1.3)
POD LOS (day)	18.5 (10.2)
Mortality	2 (9.5%)

Values are the mean (SD) or the number of patients (proportion, %). SD; standard deviation
Op, operation; ICU, intensive care unit; SOW, sips of water; GPT, gass passing time; SDT, soft diet time; LOS, length of stay; POD, postoperative day

Conclusions

- ❖ During the HIPEC period, the hyperdynamic circulation state was developed and microcirculation was deteriorated with increased temperature, glucose and lactate levels.
- ❖ The present study summarizes the challenges faced by the anesthesiologists regarding the pathophysiological alterations for the cytoreductive surgery with HIPEC during the perioperative periods.