Examination of the usefulness of pulse pressure in the evaluation of the perioperative cardiac output.

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【 Background and Goal of Study 】

The accuracy of cardiac output (CO) measurement by FloTrac™-Vigileo™ system (FV, Edwards Lifesciences, Irvine, CA, USA) has been progressively improved with several software version upgrades and its clinical use has been widespread in the perioperative setting in Japan.

However, FV cannot be used in all institutions.

The technology of FV is based on the physical principal: arterial pulse pressure (PP) $\propto$ left ventricular stroke volume (SV) $\propto$ standard deviation of arterial blood pressure (BP-STD), and $SV = BP-STD \cdot \chi$.

The χ factor compensates for differences in vascular compliance and resistance. Therefore, we focused on PP.

The aim of this study was to confirm whether monitoring of PP changes is useful for hemodynamic management in intraoperative setting.

$$SV = BP-STD \cdot \chi$$

χ : Arterial Compliance and Resistance

- Age
- Gender
- BSA
- Mean blood pressure (MBP)
- Skewness
- Kurtosis

【 Materials and methods 】

The study was conducted on 11 patients (ASA I ~III, age 48 to 80 yr) with sinus rhythm and

without moderate or severe valve regurgitation.

We prospectively monitored the patients by FV, collected 100 consecutive data acquired every minute during two hours.

No bolus of cardiovascular agent was injected during the collection period.

Data included heart rate, MBP, PP, SV, BP-STD and χ .

Correlations between PP and SV, BP-STD, χ were analyzed using the Pearson r-correlation coefficients.

【 Results 】

Table 1. Correlation between PP and SV

Correlation between PP and SV	cases
a strong positive correlation ($r > 0.7$)	3
a moderate positive correlation ($0.4 < r \leq 0.7$)	4
no correlation ($r \leq 0.4$)	4

Correlations between PP and SV were $0.052 \leq r \leq 0.823$: a strong positive correlation ($r > 0.7$) was observed in 3 patients and a moderate positive correlation ($0.4 < r \leq 0.7$) was observed in 4 of 11 patients.

Table 2. Patient demographics and correlation between PP and SV

Case	Age (yr)	Gender	ASA	BSA (m ²)	EF (%)	HT	Disease	PP and SV (r)
1	59	M	II	1.43	69	-	Esophageal Cancer	0.82
2	80	M	III	1.71	66	+	Liver Cancer	0.80
3	48	M	II	2.10	68	-	Lung Cancer	0.72
4	57	F	I	1.58	74	-	Mediastinal Tumor	0.48
5	77	F	II	1.44		-	Colon Cancer	0.47
6	73	F	II	1.58	65	+	Lung Cancer	0.46
7	77	F	II	1.35	69	-	Brain Cancer	0.42
8	67	M	III	1.60	51	+	ASO	0.39
9	58	F	I	1.62	72	+	Lung Cancer	0.34
10	75	F	II	1.71		+	Brain Cancer	0.28
11	77	M	II	1.71	72	-	Lung Cancer	0.05

Patient demographics had no effect on the correlation between PP and SV.

EF: ejection fraction, HT: hypertension,

M: male, F: female, ASO: arteriosclerosis obliterans.

Figure 1. The measurement items vs. PP and SV (r)

Three items (SD of SV, Mean of χ and SD of χ) had effects on the correlation between PP and SV.

SD: standard deviation

【 Summary 】

SD of SV, Mean of χ and SD of χ had effects on the correlation between PP and SV.

Table 3. Correlations between PP and SV, BP-STD, χ

No.	PP and SV (r)	PP and BP-STD (r)	PP and χ (r)
1	0.82	0.93	0.16
2	0.80	0.97	0.94
3	0.72	0.93	0.06
4	0.48	0.76	0.85
5	0.47	0.97	0.88
6	0.46	0.91	0.86
7	0.42	0.79	0.70
8	0.39	0.91	0.91
9	0.34	0.79	0.86
10	0.28	0.93	0.93
11	0.05	0.84	0.69

Correlations between PP and BP-STD were $0.757 \leq r \leq 0.969$:

a strong positive correlation was observed in all 11 patients.

Correlations between PP and χ were $0.057 \leq r \leq 0.943$:

a strong positive correlation was observed in 8 patients

and a moderate positive correlation was observed in 1 of 11 patients.

Figure 2. The correlation between PP and SV in 2 cases.

In case No.3, SD of SV was large, there was a strong correlation

between PP and SV (was no correlation between PP and χ).

In case No.10, SD of SV was small, there was a strong correlation

between PP and χ , however, was no correlation between PP and SV.

【 Discussion 】

➤ In unstable hemodynamic cases, we should monitor FV system. The larger SD of SV was, the stronger correlation between PP and SV was. This result was useful in clinical setting.

➤ In small SD of SV cases, there was no correlation between PP and SV, while there were strong correlations between PP and BP-STD, χ . The reason was unclear in this study.

➤ In this study, only 11 patients were enrolled.

Further investigation in different patient population is required.

【 Conclusions 】

PP was proportional to SV in 7 of 11 patients.

SD of SV, Mean of χ and SV of χ had effects on the correlation between PP and SV.

Further study is needed in order to consider monitoring of PP change as a useful indicator of hemodynamic management.