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Comparison of cardiac output estimation by FloTrac/Vigileo™ and intermittent pulmonary artery thermodilution in patient with Takayasu arteritis

The Editor,

Pulmonary artery catheters (PAC) measure cardiac output by thermodilution technique, but FloTrac sensor and Vigileo™ monitor calculate cardiac output (CO) by analyzing arterial pressure waveform.[1] Chronic inflammatory diseases of major arteries like Takayasu's arteritis (TA) alter arterial compliance, vascular resistance and characteristics of arterial pressure waveform.[2] Thus, we compared CO estimations using both the techniques in a patient with Takayasu arteritis.

A 40-year old, 65 kg male, with Takayasu arteritis and chronic renal failure, was admitted for renal transplant. Transthoracic echocardiography revealed left ventricle (LV) dysfunction with LV ejection fraction of 29%. CT angiogram showed 60% stenosis of right renal artery with involvement of celiac axis, superior mesenteric, and inferior mesenteric arteries.

General anesthesia with epidural analgesia was administered. Pulmonary artery catheterization and right radial artery catheterization was done. FloTrac/Vigileo™ was connected, patient data (age, gender, body weight, height) entered, the system zeroed and CO measurement initiated. CO measured by thermodilution technique was considered gold standard. Measurements were made at intervals of 45 min with three injections of 0.9% NaCl (10 ml, 4−6°C) using closed cold-injectate-delivery system and the mean value recorded. To compare the results and determine accuracy of estimation of cardiac output using FloTrac/Vigileo™, we calculated "Percent Error" [Table 1].

Table 1: Measurements of cardiac output (CO) using FloTrac/Vigileo™ [CO(FloTrac)] and pulmonary artery catheter [CO (PAC)]

Time (min)	CO (PAC) (l/min)	CO (FloTrac) (l/min)	Percentage error (%)
15	4.90	8.40	71
60	5.00	8.90	78
105	4.55	8.80	93
150	5.00	10.20	104
195	5.65	9.00	59
240	6.00	9.70	62
285	4.50	8.70	93
330	7.20	10.70	49
375	7.10	12.10	70
420	5.00	10.40	108
465	6.40	12.70	98
510	7.30	10.90	49

Time of induction was considered as time 0, Formula for percentage error (% error) = [(Experimental value − true value) / true value] × 100%, Experimental value is CO(FloTrac); true value is CO (PAC).

Surgical duration was 9 h and the patient was hemodynamically stable at all points of measurements. He was extubated before transfer to renal intensive care unit and his postoperative course was uneventful.

There was an overestimation in measurement of CO with percentage error varying from 49% to 108% using FloTrac/Vigileo™ at all time intervals.

The FloTrac/Vigileo™ calculates cardiac output (CO) based on following equation:

$$CO = \text{heart rate (HR)} \times \text{stroke volume (SV)}, \quad (1)$$

where SV is dependent on two variables, i.e., pulse pressure and vascular resistance and compliance. Thus, Equation (1) can be expressed as $CO = HR \times \sigma_{AP} \times \chi$, where σ_{AP} is the standard deviation of arterial pressure and χ is a measure of vascular tone.

$$\chi = M(\text{HR}, \sigma_{AP}, C(P), \text{BSA}, \text{MAP}, \mu_{3AP}, \mu_{4AP}), \quad (2)$$

where M is multivariate approximating function M, MAP is the mean arterial pressure, $C(P)$ is a function of arterial compliance, μ_{3AP} and μ_{4AP} are skewness and kurtosis of arterial pressure data and BSA is body surface area calculated from weight and height.[3]

$C(P)$ is further derived using method of Langewouters, which uses the aortic compliance data generated from cadaver studies.[4] Bank *et al.*[5] have described a technique to study the elastic properties of arteries in patients with vascular pathology and a model to estimate mechanical parameters of the human brachial artery *in vivo*. The pulse wave analysis algorithm does

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not incorporate the contributions of collagen, elastin, and smooth muscle to arterial mechanical properties in humans with vascular pathology, and thus needs a modification in its algorithm based on model proposed by Bank *et al*.[5]

Insertion of PAC requires floatation through right side of the heart. However, only catheterization of peripheral artery is needed for determination of CO using FloTrac/Vigileo™. Being a minimally invasive technique, it is now being used preferentially for estimation of CO. However, findings from the above case show that validity of its results are questionable in patients with pathological lesions of vasculature. Further research is needed with the device in different clinical scenarios to develop a clear understanding of its limitations and devise new algorithms to analyze pulse waves.

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REFERENCES

1. Manecke GR. Edwards FloTrac sensor and Vigileo monitor: Easy, accurate, reliable cardiac output assessment using the arterial pulse wave. Expert Rev Med Devices 2005;2:523-7.
2. Thorburn JR, James MF. Anaesthetic management of Takayasu's arteritis. Anaesthesia 1986;41:734-8.
3. Button D, Weibel L, Reuthebuch O, Genoni M, Zollinger A, Hofer CK. Clinical evaluation of the FloTrac/Vigileo system and two established continuous cardiac output monitoring devices in patients undergoing cardiac surgery. Br J Anaesth 2007;99:329-36.
4. Langewouters GJ, Wesseling KH, Goedhard WJ. The pressure dependent dynamic elasticity of 35 thoracic and 16 abdominal human aortas *in vitro* described by a five component model. J B iomech 1985;18:613-20.
5. Bank AJ, Wang H, Holte JE, Mullen K, Shammas R, Kubo SH. Contribution of collagen, elastin, and smooth muscle to *in vivo* human brachial artery wall stress and elastic modulus. Circulation 1996;94:3263-70.

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Quick Response Code:	Website: www.annals.in
	DOI: 10.4103/0971-9784.81579