Original Article

The utility of limited trans-thoracic echocardiography in the stratification of pulse pressure variation: A feasibility study in major open abdominal surgery

ABSTRACT

Background and Aim: Limitation in use of pulse pressure variation (PPV) in predicting fluid responsiveness (FR) in hypotensive patients is encountered when values are in the "gray zone" (8–13%). Dynamic arterial elastance (E_{adyn} = PPV/SVV) can be used in such situations to predict arterial pressure response to volume expansion (VE). In our study, we used respiratory variation of ascending aorta velocity time integral (AoVTI) calculated from suprasternal window as a surrogate of stroke volume variation (SVV). Fluids/vasopressors were administered to hypotensive patients intraoperatively based on value of E_{adyn}. Aim was to assess feasibility and utility of suprasternal echocardiography in the above-mentioned subset of patients.

Materials and Methods: Hemodynamic data were monitored and respiratory variation in AoVTI was recorded using suprasternal echocardiography at all time points when patients developed hypotension (systolic blood pressure <90 mm Hg/<20% of baseline for 5 min) and at randomly selected time intervals when hemodynamic stability was maintained. VE with 250 ml of Ringer lactate (RL) was done in hypotensive patients with PPV value of 8–13% and E_{adyn} >0.9. Increase of >15% in AoVTI after VE defined "fluid responsiveness."

Results: Twenty-eight patients were enrolled, but three were excluded in view of left ventricular systolic dysfunction detected during preinduction echocardiography. Hemodynamic and echocardiographic data were recorded at 538 observation points in 25 adults. Hypotension occurred in 247 data sets, and in 168 data sets, value of PPV was 8–13%. VE was carried out in only those 131 data sets in which the value of E_{adyn} was >0.9. Area under the curve (AUC) for VE as an intervention in the indeterminate (PPV 8–13%) group was 0.574 (0.49–0.68, 95% CI, $P < 0.049$), and in the observation set with PPV >13, the AUC value was 0.7 (0.59–0.98, 95% CI, $P < 0.01$).

Conclusions: Echocardiography using the suprasternal window in the operating room during abdominal surgery is feasible, but the utility of E_{adyn} in stratification of patients with PPV 8–13% is inconclusive.

Key words: Hemodynamic monitoring; intraoperative; transesophageal echocardiography

Introduction

Monitoring of volume status and evaluation of response to fluid therapy are essential to ensure organ perfusion and avoid fluid overload.[1] Perioperative fluid management has been a topic of much debate and recent evidence suggests

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that rationale and titrated fluid therapy improves outcomes after major abdominal surgery.[1] Dynamic indices of preload such as systolic pressure variation (SPV), pulse pressure variation (PPV), and stroke volume variation (SVV) are being used to guide fluid therapy in the perioperative period.[2,3] The estimated area under the curve (AUC) for predicting fluid responsiveness (FR) with the use of above-mentioned indices ranges from 0.86 to 0.94.[4] PPV, SVV, and stroke volume index are inconclusive in predicting FR when their values are in the "gray zone," i.e., between 8 and 13%, and this necessitates the use of additional hemodynamic/echocardiographic parameters for optimum management of hypotensive patients.[4-6]

Hemodynamic resuscitation is aimed at achieving adequate cardiac output [stroke volume (SV)] and a sufficient mean arterial pressure (MAP) for adequate end organ perfusion. "Fluid responsiveness" has been defined on the basis of >15% increase in SV after volume expansion (VE). But it is to be noted that increase in arterial pressure is dependent on two factors: increase in SV and a high arterial tone. Current literature advocates the use of dynamic arterial elastance (E_{adyn}) to predict arterial response to VE in patients in the gray zone.[7] A value of >0.9 of E_{adyn} (ratio of PPV to SVV) is reported to predict a MAP increase after fluid administration with a sensitivity of 93.75% and a specificity of 100%.[8]

Transthoracic echocardiography (TTE) is a noninvasive bedside diagnostic modality for the estimation of SV. Measurement of respiratory variation of aortic velocity time integral (VTI) using TTE and its percentage variation within the same patient after a fluid challenge have been used as a surrogate for SVV and FR in numerous studies.[9-11] We have used similar methodology in our study but imaged the ascending aorta through the suprasternal window. In a pulsatile and accelerated flow imaged via spectral Doppler study, the VTI is the integral under the velocity–time curve and is considered a surrogate of SV.[12] This assumption is based on the principle of mass conservation, which states that flows traversing valves or orifices are the same, unless valvular regurgitation or intracardiac shunting exists.

Aim of our study was to assess the utility and feasibility of suprasternal echocardiography in estimating respiratory variation in AoVTI as a surrogate for SVV and calculate dynamic arterial elastance (E_{adyn} = PPV/SVV) in hypotensive patients with values of PPV in the gray zone (8–13%). VE was done only when the value of E_{adyn} was >0.9 and "FR" was defined based on a >15% increase in AoVTI after VE.

Materials and Methods

After approval from the Institute Ethics Committee and written informed consent of the patients, this prospective interventional pilot study was conducted in our tertiary care hospital from August 2014 to August 2015. Adult patients aged 18–65 years scheduled for elective open abdominal surgery under general anesthesia were assessed for eligibility in the preoperative area. Sample size calculation was not done because it was a pilot study.

Patients with history of heart failure or subnormal left or right ventricular function on preoperative echocardiography, history of cardiac dysrhythmias, valvular heart disease, intracardiac shunt, contraindications to the placement of a radial artery catheter, those undergoing simultaneous open chest procedure, and those refusing consent were excluded.

Anesthetic management

Preoperative holding area

Nothing by mouth (NPO) status was confirmed in the preoperative area. Patients without a formal echocardiography documentation (performed as part of preanesthetic evaluation in view of suspected cardiac pathology/poor functional status/morbid obesity, etc.) were scanned by a cardiac anesthetist (formal training in TTE/transesophageal electrocardiography) and a rapid qualitative/quantitative assessment of cardiac function made (focused cardiac ultrasound). Scanning procedure was standardized and customized to enable accurate recording of parameters mentioned in the proforma [Appendix 1]. Patients with cardiac abnormalities were excluded and referred to a cardiologist for further workup.

Operation theatre

Standard American Society of Anesthesiologist (ASA) monitors (electrocardiogram, noninvasive blood pressure, pulse oximetry) were attached, 18/16G cannula inserted, and epidural catheters (lumbar/thoracic) placed. Radial artery catheters were transduced and PPV was measured on Avance™ Anaesthesia S/5 workstation monitoring platform (DatexOhmedaInc, Madison, WI, USA). Choice of drugs for induction and maintenance of anesthesia were left to the discretion of the attending anesthesiologist (TS, VS, RD). The placement of a central venous catheter was determined on patient-to-patient basis. All patients received a baseline fluid infusion of about 2 ml/kg/h + urine output + blood loss.

Intraoperative data recording

Hemodynamic and echocardiographic data were recorded at all time points when patients developed hypotension (systolic blood pressure (SBP) <90 mm Hg or <20% of baseline for a minimum duration of 5 min) [Figure 3] and

at randomly selected time intervals when hemodynamic stability was maintained. A 1–5 MHz phased array transducer (SonoSite, Bothell, WA) was placed in the suprasternal notch with the probe marker oriented toward the patient's right hip to image the ascending aorta, descending aorta, arch of aorta, brachiocephalic vein, and the right pulmonary artery. For optimization of the image quality, the patient's head was rotated to the side and a towel roll placed under the patient's shoulders to extend the neck. Ascending AoVTI was estimated by tracing the spectral Doppler envelope in suprasternal window. Baseline value of ascending AoVTI was measured as the median value in centimeters over three consecutive respiratory cycles. Hemodynamic data [SBP, MAP, central venous pressure (CVP), heart rate (HR), SPV, PPV] were recorded from the Avance™ Anesthesia S/5 workstation monitoring platform (Datex Ohmeda Inc., Madison, WI). Maximum and minimum values of AoVTI (in cm) measured over three consecutive respiratory cycles were used to compute VTI variation, which was considered as a surrogate of SVV.

$$\text{VTI variation}\,(\%) = \frac{\text{VTI}_{\max} - \text{VTI}_{\min}}{(\text{VTI}_{\max} + \text{VTI}_{\min}) \times 0.5} \times 100$$

Intervention protocol and the decision box for management of hypotension

Hypotension was defined as SBP <90 mm Hg or <20% of baseline for >5 min. No intervention was done when the hemodynamics was stable. PPV was used to guide fluid therapy when patients developed hypotension [Figure 1]. VE was done in patients with PPV >13% till the point the blood pressures normalized or PPV decreased to <8%. Vasopressors (1 μg/kg of phenylephrine) were administered to patients with hypotension and PPV <8%. Patients with PPV in the gray zone (8–13%) were managed based on value of E_{adyn}.

Dynamic arterial elastance (E_{adyn}) = PPV/SVV or PPV/VTI variation.

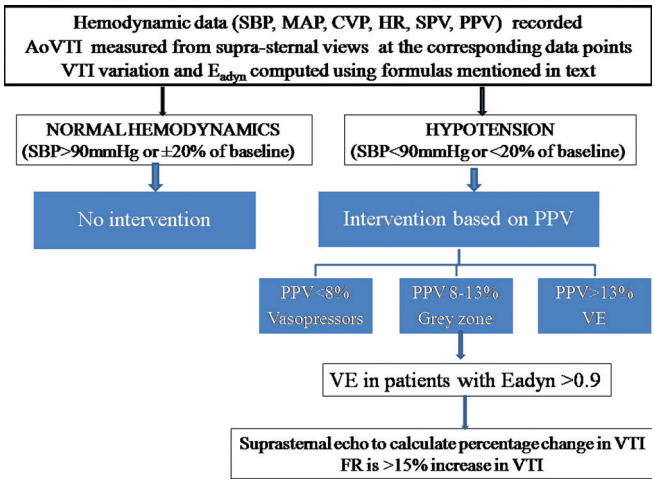

Figure 1: Decision box for management of hypotension

VE (250 ml of ringer lactate) was done for values E_{adyn} >0.9 and a phenylephrine bolus (1 μg/kg) was administered for E_{adyn} <0.9.

Response to intervention protocol

Suprasternal TTE was repeated 20 min after VE. AoVTI (post VE) was measured as the median value in centimeters over three consecutive respiratory cycles. ΔVTI(%) was calculated as follows:

$$\Delta\text{VTI}\,(\%) = \frac{\text{VTI}_{\text{Baseline}} - \text{VTI}_{\text{Volume Expansion}}}{\text{VTI}_{\text{Baseline}}} \times 100$$

Change in AoVTI after VE was recorded and >15% increase was used to define "FR." VTI is the integral under the velocity–time curve and is considered a surrogate of SV.

Demographic data, input/output/fluid balance (crystalloid, colloid, blood products, blood loss, urine output), and acid base status (arterial blood gas analysis) were recorded/monitored.

It was a pilot study, and thus no sample size estimation was done. Count data, parametric, and nonparametric data were analyzed using the Chi-square, the paired Student's *t*-test, and the Mann–Whitney *U*-test, respectively. Receiver operator characteristic (ROC) curve was constructed using a nonparametric method for PPV <8, 8–13, and >13. All analyses were performed on Statistical Package for the Social Sciences, Statistics version 22.

Results

Sixty patients scheduled for major open abdominal surgeries were assessed for eligibility, but 38 were excluded, and thus only 28 patients were enrolled. Preoperative focused cardiac ultrasound (FOCUS) detected left ventricular systolic dysfunction in three patients, which were subsequently excluded from the study [Figure 2]. The demographic profile of the patients is summarized in Table 1. Majority were males (72%); nine (36%) did not have any comorbid condition (ASA 1 category). Sixteen patients (64%) belonged to ASA 2 category, and the distribution of comorbid conditions is summarized in Table 2.

Right jugular venous cannulation was done in five (20%) patients. Thoracic epidural was inserted in 96% and the remaining received lumbar epidural analgesia. Surgical procedures performed were pancreatoduodectomy (n = 6), hepaticojejunostomy (n = 5), extended cholecystectomy (n = 4), resection, and anastomosis for gastrointestinal malignancies (n = 4), gastrectomy with hepaticojejunostomy (n = 2), Frey's (n = 2), cyst excision, and hepaticojejunostomy (n = 1), excision of tail of pancreas, and splenectomy (n = 1).

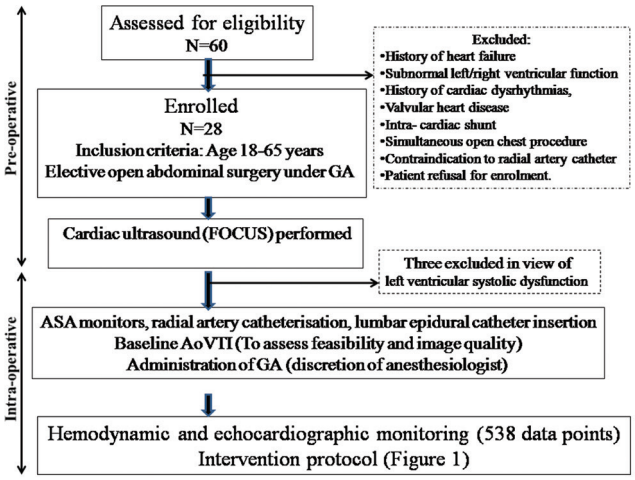

Figure 2: Study flow diagram

Hemodynamic (SBP, MAP, CVP, HR, SPV, PPV) and echocardiographic data (respiratory variation in AoVTI and mean value of AoVTI imaged from suprasternal window) was recorded at 538 data points from 25 patients undergoing major open abdominal surgery. In 247 data points, SBP was <90 mm Hg or <20% of baseline for a minimum duration of 5 min. Based on our intervention protocol for the management of hypotension, the following therapy was instituted:

Phenylephrine bolus (1 μg/kg) was administered in 42 observation sets, which recorded PPV <8. VTI was calculated 20 min after the intervention. In 60% of observations, administration of phenylephrine led to a >15% increase in VTI (increase in SV). In only one patient, a decrement in VTI was recorded.

Thirty-seven observation sets recorded PPV >13 and received VE. VTI was calculated 20 min after the intervention. In 75.7% of observations, VE led to >15% increase in VTI (fluid responders). There was no decrease in VTI at any data point.

In 168 observation sets the value of PPV was 8–13 (gray zone). The dynamic arterial elastance (E_{adyn}) was >0.9 in 131 observation sets and fluid expansion was the intervention selected; 63.4% of these were FR (based on a repeat AoVTI measurement 20 min after VE). Only 3 (2%) data sets recorded a decrement in the VTI. The remaining 37 patients with E_{adyn} <0.9 were administered phenylephrine bolus (1 μg/kg).

The intraoperative clinical status of the patients is summarized in Table 3. The patients were ventilated with volume-controlled ventilation, with a tidal volume of 8 ml/kg and a PEEP of 4 cm of H_2O. All the patients had pH in the physiological range. One patient required 500 ml of colloid; none of the patients were transfused with blood or blood products. The patients urine output was >50 ml/h throughout the procedure.

When ROC curves were obtained using the above data set the AUC for VE as an intervention in the "gray zone group" (PPV: 8–13) was 0.574 (0.49–0.68, 95% confidence interval (CI), $P < 0.049$) [Figure 4]. In the observation set with PPV >13, the AUC value obtained in this pilot investigation was 0.7 (0.59–0.98, 95% CI, $P < 0.01$) [Figure 5]. Although not formally intended to study, but the effect of phenylephrine on >15% increase in VTI as determined by the AUC was equivocal (0.47 (0.28–0.64, 95% CI).

Table 1: Demographic data

Parameter	Mean±SD	Range
Age (in years)	53.12±12.97	27-76
Height (in cm)	166.3±8.8	148-178
Weight (in kg)	62.2±8.7	48-91
Body surface area (BSA; in m^2)	1.7±0.13	1.39-1.92
Body mass index (BMI kg m^{-2})	22.6±3.8	16.5-36.5

Table 2: Distribution of comorbidities

Comorbidities	No. of patients (*n*)
Hypertension	10
Diabetes mellitus	7
Liver disease	3
Smoker	5
Alcoholic	4

Table 3: Details of the intraoperative clinical status of the patients

Clinical parameters	Value (mean±SD)
Ventilatory parameters	
Peak airway pressure	19.12±2.81 cm of H_2O
Mean airway pressure	7.6±0.7 cm of H_2O
Arterial blood gas analysis	
pH	7.393±0.049
PaO_2	156±29.16 mm Hg
$PaCO_2$	38.43±2.87 mm Hg
Bicarbonate (HCO_3^-)	22.37±1.87 mEq
Base deficit	−2.04±1.9
Na^+	139.86±4.82 mEq
K^+	3.65±0.51 mEq
Ionized Ca^{2+}	0.971±0.24 mEq
Hematocrit	31.4±6.07%
Fluid balance	
Volume of crystalloid infused	2000±0.63 L
Total urine output	668±167.3 ml
Blood loss	500±180 ml
Positive balance	1080±638 ml

All values are expressed as mean±SD

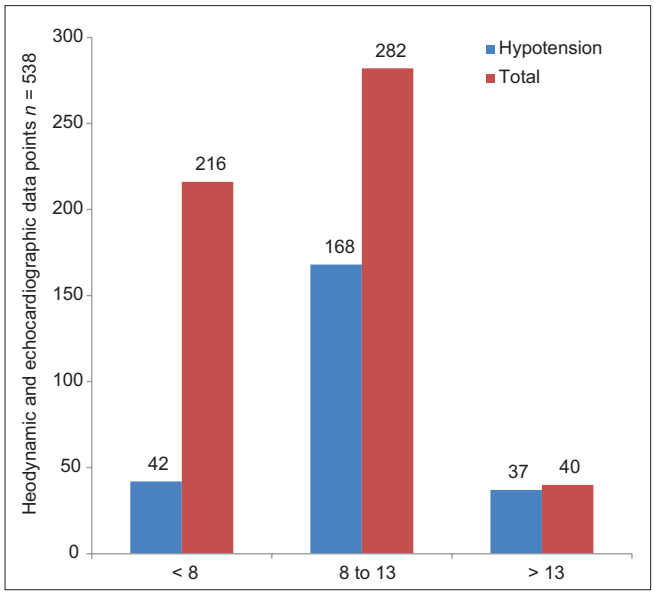

Figure 3: Subgrouping of data points (*n* = 538) into hypotensive group (SBP <90 mm Hg or <20% of baseline for >5 min) at three different values of PPV; <8, 8–13, and >13%

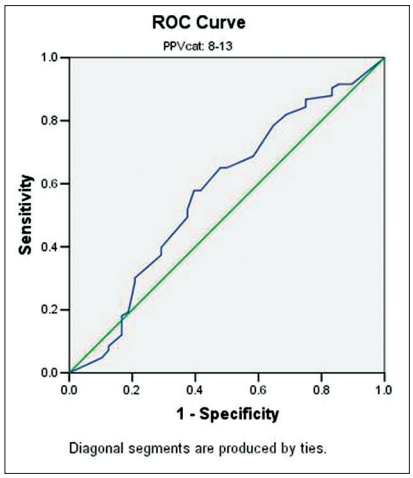

Figure 4: Receiver operator curve of the interventional data of intermediate PPV group (8–13)

Discussion

We demonstrate the feasibility of using the suprasternal window on TTE to calculate ascending AoVTI and its variation as a surrogate of SV and SVV, respectively, in patients undergoing major open abdominal surgeries. There was no hindrance to the operative field during echocardiography and the anesthesiologist imaged the cardiac vessels with ergonomic ease from the head end. In our pilot study, VE led to >15% increase in VTI in 63.4% of observation points with E_{adyn} of >0.9 and value of PPV in the gray zone. The AUC for VE as an intervention in the indeterminate (PPV 8–13) group was 0.574 (0.49–0.68, 95% CI, $P < 0.049$, and thus inconclusive. Further studies with a larger sample size are needed to assess the ability of dynamic arterial elastance to predict the arterial pressure response after volume loading in hypotensive patients with values of PPV in the gray zone.

Cannesson *et al*.[13] published the diagnostic accuracy of PPV in predicting FR in patient with values of PPV in the gray zone. The reported percentage of patients with PPV in the gray zone (9–13%) in their study were 24%, but in our study the value was 52%. This can be explained partly by the wider range selected in our study (8–13) and the different subset of patients; major open abdominal surgeries in our study and a mix of patients in the previous studies (abdominal aorta surgery, cardiac surgery before chest opening, and nonvascular abdominal surgeries). The maximum predictive value for FR in our study was seen in the data set with PPV >13; the value of AUC was 0.7, and is lower than those previously quoted.[5] This can be partly explained by the less number of data points recorded; the ROC curve in our study is likely poorly calibrated with respect to other considerably larger data sets. There is potential limitation of the ROC curve analysis for evaluation of dynamic variables because it necessitates a fixed definition of FR, whereas according to the Frank–Starling curve, the response to VE is actually a continuum of values ranging from "no increase" (or even a decrease) to a "large increase" in SV. Also, the benefit–risk balance of fluid administration may vary between patients and hence an increase in pressures (MAP) after a therapeutic intervention has more clinical relevance than the value of AUC.

This study was conducted as a part of a quality initiative to improve outcome in patient undergoing a major open abdominal surgery and aims to highlight the following important aspects of hemodynamic resuscitation in a hypotensive patient:

Judicious/restricted fluid administration enhances patient recovery and goal-directed fluid therapy should be used in all cases.[1] Invasive (based on arterial waveform analysis) and noninvasive modalities (TTE) can be used to assess volume status and FR.[2,11] Hemodynamic resuscitation is aimed at increasing both the cardiac output and MAP.

TTE calculation of SV is done using the product of VTI of the left ventricular outflow tract (LVOT) and the LVOT area (which is constant). The use of LVOT-VTI as a surrogate for SV with a normal value of >20 cm is the best single measure of cardiac output/overall cardiac performance.[14] Measurement of subaortic variation in VTI with passive leg raising and a >10% change in VTI after 100 ml of fluid challenge has been used to predict FR.[15,16]

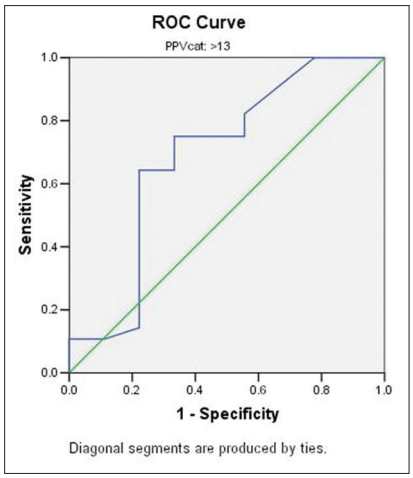

Figure 5: Receiver operator curve of interventional data of the group where PPV is >13

In our study we have used AoVTI and assessed response to our therapeutic interventions based on the concept of "following trends," which is the basis of functional hemodynamic monitoring. In our study VTI trends were followed in the same site where the VTI was initially obtained (ascending aorta imaged through suprasternal window). A consistent increase in the VTI (>15%) after interventions (e.g., fluids, vasopressors) was considered a successful response. Blanco *et al*.[17] have discussed the use of VTI of right ventricular outflow tract (RVOT) flow or mitral valve for periodic monitoring and assessment of therapeutic responses in hypotensive patients. Doppler signal via a suprasternal window can also calculate VTI in the descending aorta where the normal value is 12 cm or greater in contrast to LVOT VTI, which has 18 cm as the normal value.[18] This is because the flow through the descending aorta is 70% of the flow exiting the ascending aorta; 30% loss occurs due to flow to coronary and supraaortic vessels.

The assumption that increasing SV will increase arterial pressure is not always true. It depends on the arterial tone, which is a function of the slope of the arterial volume–pressure relationship, and is denoted in our study as the dynamic arterial elastance (E_{adyn}).

We also calculated the change in VTI after phenylephrine bolus in hypotensive patients with PPV value <8. In 60% of the observations, there was a significant increase in SV, and this can be explained by mobilization of stressed volume into the central circulation.

Total amount of fluid administered intraoperatively in our study was approximately 2.0 l and the positive balance was 1080 ± 638 ml. Wright *et al*.[19] have studied the perioperative fluid balance and outcome following pancreaticoduodenectomy retrospectively and divided patients in four subgroups based on the volume of fluid administered intraoperatively. The morbidity rates reported by them in patients in first (+1450–3340 ml), second (+3341–4325 ml), third (+4326–5362 ml), and fourth (+5363–15950 ml) quartile were 28.6, 32.6, 54.8, and 45.2%, respectively. The authors have reported significantly lower length of hospital stay and fewer morbid complications in the first quartile. Patients in our study qualify to be in the first quartile and thus we can extrapolate on the basis of previous study, a morbidity of 28%.

Use of dynamic indices and TTE obviated the need for placement of central venous catheters (inserted in only five patients in view of difficult venous access) in our study.

Limitations

This is only a pilot study and the small sample size is a major limitation although attempts have been made to negate this effect by recording >500 data sets. We used at least five respiratory cycles to determine the PPV at a given time, because this has been described as the most rigorous and sensitive method of obtaining this parameter.

It is to be noted that we used AoVTI in our study and this is not the gold standard method of measuring cardiac output. Thermodilution techniques are the gold standard as all echo-based methods have intra and interobserver variability.[20] In our study we tried to minimize errors due to interobserver variability by assigning only one of the author (AJ) who is a cardiac anesthesiologist (single observer) the role of conducting the echocardiographic examinations. It was ensured that he was blinded for the hemodynamic parameters at the point of assessment. Philips *et al*.[21] have also reported the echo Doppler techniques to be more sensitive than thermodilution in ovine cardiac output validation study.

Another limitation of our study is that long-term follow-up was not done. We did not have any intraoperative complication and very low values of standard base excess measured intraoperatively to testify good hemodynamic management. Thus, we do not suspect any postoperative sequelae. Although not systematically studied, we assume that the judicious use of fluids facilitated by the use of dynamic indices and TTE maintained normal hemostasis.

In our study the echocardiography was done by a cardiac anesthetist and the imaging ability of a noncardiac anesthetist was not assessed. Dinh *et al*.[22] in their study reported that a trained emergency physician could obtain an optimal LVOT

VTI in 78.4% of 97 studied patients. Adequate short-term training in focused echocardiography will further improve the imaging skills, and thus will not hinder with the acceptance of the intervention protocol mentioned in the study.

Conclusion

The results of this pilot study demonstrate the feasibility of performance of TTE using the suprasternal window for measurement of ascending AoVTI. The utility of calculating the dynamic arterial elastance in hypotensive patients with PPV values in the gray zone (8–13%) could not be established as the AUC was 0.574. Consonant with previously published literature patients with a PPV value >13 demonstrate the best response to volume administration. The success of the therapeutic modality chosen based on the intervention protocol used in this study needs to be evaluated in subsequent studies based on the arterial pressure response exhibited to the therapeutic modality adopted. Measurement of LVOT VTI and if that is not possible measurement of VTI at RVOT, mitral valve at the annular level, or descending aorta/ascending aorta from a suprasternal view for SV estimation may be a useful data point for monitoring the results of therapeutic interventions in patients with hypotension. We emphasize that the changes in cardiac function in response to treatments are more important than individual static measurements.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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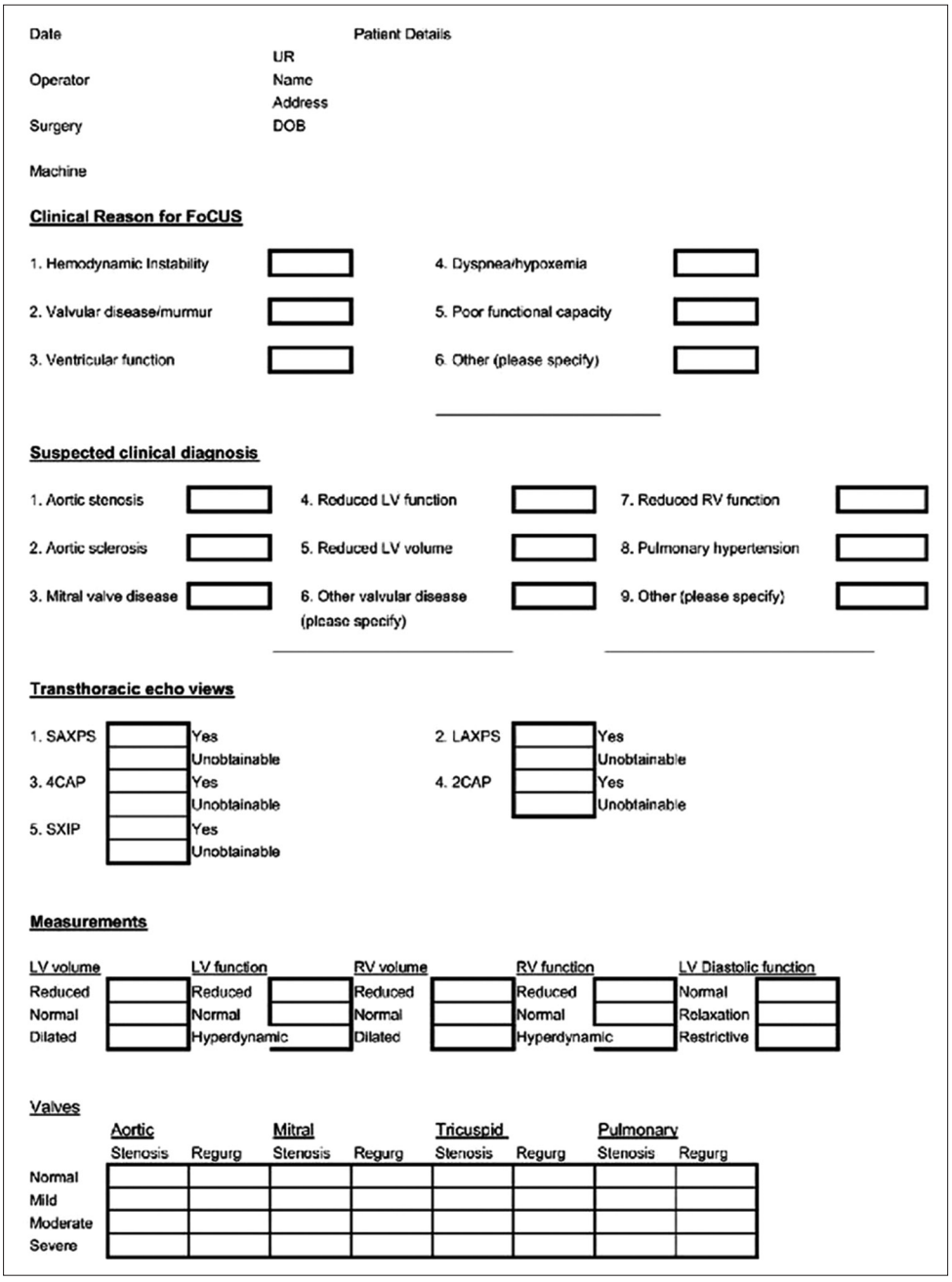
Appendix 1



Date

Operator

Surgery

Machine

Patient Details

UR

Name

Address

DOB

Clinical Reason for FoCUS

1. Hemodynamic Instability ☐
2. Valvular disease/murmur ☐
3. Ventricular function ☐
4. Dyspnea/hypoxemia ☐
5. Poor functional capacity ☐
6. Other (please specify) ☐

Suspected clinical diagnosis

1. Aortic stenosis ☐
2. Aortic sclerosis ☐
3. Mitral valve disease ☐
4. Reduced LV function ☐
5. Reduced LV volume ☐
6. Other valvular disease (please specify) ☐
7. Reduced RV function ☐
8. Pulmonary hypertension ☐
9. Other (please specify) ☐

Transthoracic echo views

1. SAXPS ☐ Yes ☐ Unobtainable
2. LAXPS ☐ Yes ☐ Unobtainable
3. 4CAP ☐ Yes ☐ Unobtainable
4. 2CAP ☐ Yes ☐ Unobtainable
5. SXIP ☐ Yes ☐ Unobtainable

Measurements

LV volume		LV function		RV volume		RV function		LV Diastolic function	
Reduced	☐	Reduced	☐	Reduced	☐	Reduced	☐	Normal	☐
Normal	☐	Normal	☐	Normal	☐	Normal	☐	Relaxation	☐
Dilated	☐	Hyperdynamic	☐	Dilated	☐	Hyperdynamic	☐	Restrictive	☐

Valves

	Aortic		Mitral		Tricuspid		Pulmonary	
	Stenosis	Regurg	Stenosis	Regurg	Stenosis	Regurg	Stenosis	Regurg
Normal								
Mild								
Moderate								
Severe								

Dimensions

LVEDD (3.0-5.6cm)	☐	LVEDA (8-14 cm2)	☐	LA size (<4 cm)	☐	TR Vmax (m/sec)	☐	AV velocity (<1.5m/sec)	☐
LVESD	☐	LVESA	☐	LA Area	☐	RVSP (<25mmHg)	☐	Peak grad	☐
FS (>25%)	☐	FAC (50-65%)	☐					Mean grad	☐

SAXPS, Parasternal short axis; LAXPS, Parasternal long axis; 4CAP, 4-chamber apical; 2CAP, 2-chamber apical; SXIP, Subxiphoid view; LVEDD, Left ventricle end diastolic diameter; LVEDA, Left ventricle end diastolic area; LVESD, Left ventricle end systolic diameter; LVESA, Left ventricle end systolic area; LA, Left atria; FS, Fractional shortening; FAC, Fractional area change; RVSP, Right ventricular systolic pressure; TR, Tricuspid; AV, Atrioventricular

The dimensions such as TR Vmax, AV velocity, RVSP, peak, and mean gradient were not mandatory to record and were left to the discretion of the cardiac anesthetist performing the scan.

Comments:

- The cardiac anesthesiologist performing the imaging is to comment at the end of the proforma and give an overview of the result of the imaging
- Name and designation of the anesthesiologist performing echocardiography to be clearly mentioned
- Recommendation for any further advanced imaging/cardiology consult if needed to be clearly mentioned.

*The proforma was made keeping in mind the recommendations made by Cowie *et al*.[23] and is a standard proforma used in our institute whenever a focused cardiac echocardiography is to be performed. When performed intraoperatively then an additional text box is also included, which is depicted below

Change in Management

1. Proceed with case	☐	6. Fluids - bolus restrict	☐ ☐
2. Cancel case	☐	7. Inotropes	☐
3. Change anesthesia plan (e.g GA/regional)	☐	8. Vasoconstrictors	☐
4. Change monitoring (e.g Aline, CVP)	☐	9. Prevent further Ix	☐
5. No change in management CVP, post op ICU)	☐	10. Other (please specify)	☐
Refer formal TTE	☐		