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MEETING ABSTRACTS

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Acute respiratory failure and MV experimental studies

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Comparison of three methods to measure lung compliance during a decremental PEEP trial in an experimental model of ARDS

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INTRODUCTION. Optimal PEEP is still a matter of debate in ARDS patients. PEEP is by nature an expiratory setting aiming at maintaining lung recruitment reached during the breathing cycle and/or during a recruitment manoeuver. Decremental PEEP trial after a recruitment manoeuver is an attractive method to detect optimal PEEP. This latter can be defined from different variables, lung compliance being one of them.

OBJECTIVES. To compare three methods to measure lung compliance and to find out which is associated with the optimal PEEP (maximal compliance) during a decremental PEEP trial.

METHODS. Female piglets were anesthetized, paralyzed, tracheotomized and mechanically ventilated (Carestation, GE Healthcare) and acute lung injury was performed by saline lavage. Once PaO2 was lower than 100 mmHg under 100% FIO2, a recruitment manoeuver (sustained inflation to 40 cm H2O for 30 seconds) was performed followed by cycling mechanical ventilation in volume controlled mode, constant flow inflation, 100% FIO2, tidal volume 6 ml/kg body weight, respiratory rate 35 breaths/min. PEEP was initially set to 20 cmH2O then decreased by 2 cmH_2O-steps lasting 2 minutes each to 2 cmH_2O. At each PEEP step, airway pressure, esophageal pressure and airflow were acquired (Biopac 100), whole lung CT scan was performed during end-expiratory and end-inspiratory pause, and finally electrical impedance tomography (EIT) (Göttingen University) signal was acquired. Compliance was inferred using three methods: i) by fitting a R-C model on recorded pressure and flow signals using a least square method (C_{lung}). ii) by using CT data (C_{scan}) as ratio of tidal volume (sum of the difference between inspiration and expiration in volume of normally aerated, poorly aerated and overaerated lung compartments) to driving pressure (plateau pressure minus PEEP). iii) by computing ratio of change in electrical impedance to driving pressure (C_{EIT}). The relationships between C_{lung}, C_{scan} and C_{EIT} were performed by using the coefficients of determination over the 10 PEEP steps in each pig.

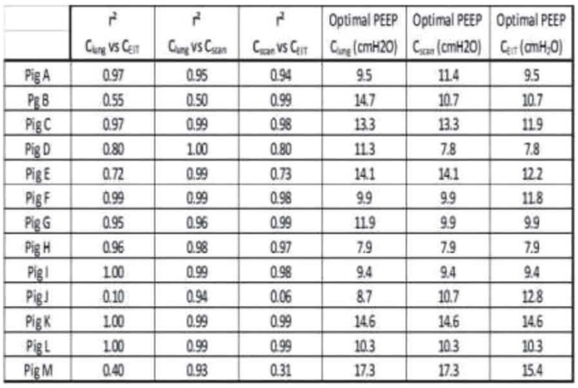
RESULTS. Thirteen pigs were analyzed. The table shows for each pig the values of coefficient of determination between each pair of compliance and the resulting optimal PEEP that maximized compliance.

CONCLUSIONS. Excellent correlation, except for pig B, was observed between C_{lung} and C_{scan} and the resulting optimal PEEP were in agreement with a difference generally less than 2 cmH_2O. Poor correlation ($r^2 \leq 0.8$) between C_{EIT} and C_{scan} was observed in 4 pigs. Nevertheless, even iln these cases the difference between optimal PEEP computed from C_{EIT} and the two other methods were small (≤2 cmH_2O).

REFERENCE(S)

Measurement of C_{lung}, which is easy to manage in adults, strongly correlated to C_{scan} and should be used to titrate optimal PEEP in decremental PEEP trial. By contrast measurement of C_{EIT}, which is the only method possible in neonates, seems less correlated to Cscan.

Table 1 (Abstract 0001) See text for description



	r^2 C_{lung} vs C_{EIT}	r^2 C_{lung} vs C_{scan}	r^2 C_{scan} vs C_{EIT}	Optimal PEEP C_{lung} (cmH2O)	Optimal PEEP C_{scan} (cmH2O)	Optimal PEEP C_{EIT} (cmH_2O)
Pig A	0.97	0.95	0.94	9.5	11.4	9.5
Pig B	0.55	0.50	0.99	14.7	10.7	10.7
Pig C	0.97	0.99	0.98	13.3	13.3	11.9
Pig D	0.80	1.00	0.80	11.3	7.8	7.8
Pig E	0.72	0.99	0.73	14.1	14.1	12.2
Pig F	0.99	0.99	0.98	9.9	9.9	11.8
Pig G	0.95	0.96	0.99	11.9	9.9	9.9
Pig H	0.96	0.98	0.97	7.9	7.9	7.9
Pig I	1.00	0.99	0.98	9.4	9.4	9.4
Pig J	0.10	0.94	0.06	8.7	10.7	12.8
Pig K	1.00	0.99	0.99	14.6	14.6	14.6
Pig L	1.00	0.99	0.99	10.3	10.3	10.3
Pig M	0.40	0.93	0.31	17.3	17.3	15.4

0002

Effect of external negative pressure versus positive end-expiratory pressure on respiratory mechanics during recruitment of experimentally induced lung injury

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INTRODUCTION. Positive end-expiratory pressure (PEEP) improves gas exchange and respiratory mechanics in patients suffering from acute lung injury. However, it itself may also induce the risk of lung overdistension and their damage. Some data suggest that the use of external negative pressure (eNP) in damaged lungs is less injurious compared to positive pressure ventilation [1].

OBJECTIVES. To compare the effect of eNP versus PEEP on lung mechanics in pigs with acute lung injury.

METHODS. Ten Large White pigs weighting 52 ± 5 kg were included in the study. Under general anaesthesia the animals were intubated and ventilation in a volume-controlled mode with F_IO_2 1.0, VT 8–10 mL kg^{-1} and I:E ratio 1:2. Respiratory rate was adjusted to

0087

Can carotid and femoral Doppler assess the effects of passive leg raising?

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INTRODUCTION. A direct measurement of cardiac index is usually needed to assess the hemodynamic effects of passive leg raising (PLR) and fluid infusion. Nevertheless, changes in carotid and femoral blood flow may be proportional to changes in cardiac output.

OBJECTIVES. We tested if Doppler assessment of carotid and femoral blood flows and of their peak velocities could reflect the changes in cardiac output during a PLR and a fluid infusion.

METHODS. In 51 critically ill patients, we performed Doppler measurements of carotid and femoral blood flows and peak systolic velocities, as well as calibrated pulse contour cardiac index, before and during the PLR and before and after fluid infusion. Arterial diameter and velocity time integral or time average velocity were used to obtain Doppler blood flow values. If cardiac index increased ≥10% during PLR, the patient was considered as a “PLR responder”. Fluid infusion (500 mL saline) was performed in PLR responders only (27 cases).

RESULTS. Considering all changes observed during PLR and fluid infusion (n = 120), cardiac index increased by 14 ± 15%, carotid blood flow by 15 ± 35% (n = 59) and femoral blood flow by 23 ± 36% (n = 14). No correlation was found between changes in cardiac index and changes in carotid and femoral blood flows (r = 0.07 and r = 0.28, respectively). In PLR responders, cardiac index increased by 19 ± 11% (n = 27), carotid blood flow by 13 ± 38% (n = 21) and femoral blood flow by 3 ± 12% (n = 3). We could not obtain a correct Doppler signal of the femoral artery in 38 patients. Neither the changes in carotid (area under the receiver operating characteristics curve (AUROC): 0.58 ± 0.10) and femoral blood flows nor the changes in their peak systolic velocities were able to detect a positive PLR test.

CONCLUSIONS. In our hands, Doppler assessment of carotid and femoral blood flows and of their peak velocities was not a reliable method to assess the changes in cardiac index during a PLR or fluid infusion.

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0088

S wave variation to predict fluid responsiveness in icu patients undergoing controlled mechanical ventilation

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INTRODUCTION. The role of echocardiography in predicting fluid responsiveness at bedside is still limited. The transesophageal echocardiography is a highly-skilled technique which was used to evaluate the aortic blood flow increase after volume expansion (VE)[1] or the respiratory changes in left ventricular outflow tract velocities (VTI)[2]. Moreover, also the use of the transthoracic echocardiography (TTE) to measure VTI is not always simply to obtain or reproduce in ICU patients[3]. TTE tissue Doppler imaging (TDI) has been proposed in different ICU setting to investigate diastolic dysfunction or false-positive pulse pressure variation. Considering that the systolic velocity wave (S wave) is correlated to the systolic ventricular function, we postulated that its variation during controlled mechanical ventilation (CMV) could be related to preload dependency.

OBJECTIVES. To assess the reliability of the dynamic variation of the systolic tissue Doppler wave (ΔSwave) to predict fluid responsiveness in ICU patients undergoing MCV.

METHODS. We studied 18 patients undergoing MCV requiring a VE (500 ml of crystalloids in 10 minutes). Hemodynamic measurements were obtained using MOSTCARE^{TM} and TTE. All the predefined validity criteria of pulse pressure variation were respected, according to the literature[4]. Study protocol consisted of 3 steps:

1) at baseline the patients were ventilated with a tidal volume (Vt) of 6 ml/kg;
2) the Vt was increased up to at least 8 ml/kg for 5 minutes;
3) Vt was decreased to baseline values and a VE was administrated.

At each step, S waves were recorded for tricuspid annulus, septal and lateral mitral annulus. ΔSwave was calculated post-hoc as the percentage change between the two highest and two lowest values of 10 consecutive S waves recorded. ROC curves were constructed considering a patient showing a CI increase ≥ 15% after VE as fluid-responder.

RESULTS. 22 patients were enrolled but 4 were excluded because of technical limitations in obtaining reliable echo images after increasing Vt, either from tricuspid or mitral annulus. The AUCs of PPV$_{6\ ml/kg}$ and of PPV$_{8\ ml/kg}$ were 0.64 (CI$_{95}$ 0.36-0.91) and 0.84 (CI$_{95}$ 0.69-1.00), respectively. The AUC of ΔSwave of the tricuspid valve was 0.74 (CI$_{95}$ 0.50-0.97) and 0.91 (CI$_{95}$ 0.78-1.0) for a Vt of 6 and ≥ 8 ml/kg, respectively. The AUC of ΔSwave of the mitral septum annulus was 0.81 (CI$_{95}$ 0.61-1.00) and 0.86 (CI$_{95}$ 0.69-1.02) for a Vt of 6 and ≥ 8 ml/kg, respectively. The AUC of ΔSwave of the mitral lateral annulus was 0.78 (CI$_{95}$ 0.69-1.02) and 0.86 (CI$_{95}$ 0.69 to 1.02) for a Vt of 6 and ≥ 8 ml/kg, respectively (see also Table 28).

CONCLUSIONS. These preliminary data show that ΔSwave could be considered as a promising echographic measurement to predict fluid responsiveness in ICU patients.

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Table 28 (Abstract 0088). See text for description

	ΔSwave Tricuspid Vt ≥ 8 ml/kg	ΔSwave Mitral Septum Vt ≥ 8 ml/kg	ΔSwave Mitral Lateral Vt ≥ 8 ml/kg
Sensitivity	80%	60%	70%
Specificity	87.5%	87.5%	87.5%
Threshold	17%	14%	14%
	ΔSwave Tricuspid Vt = 6 ml/kg	ΔSwave Mitral Septum Vt = 6 ml/kg	ΔSwave Mitral Lateral Vt = 6 ml/kg
Sensitivity	40%	50%	50%
Specificity	87.5%	87.5%	87.5%
Threshold	10%	11%	11%

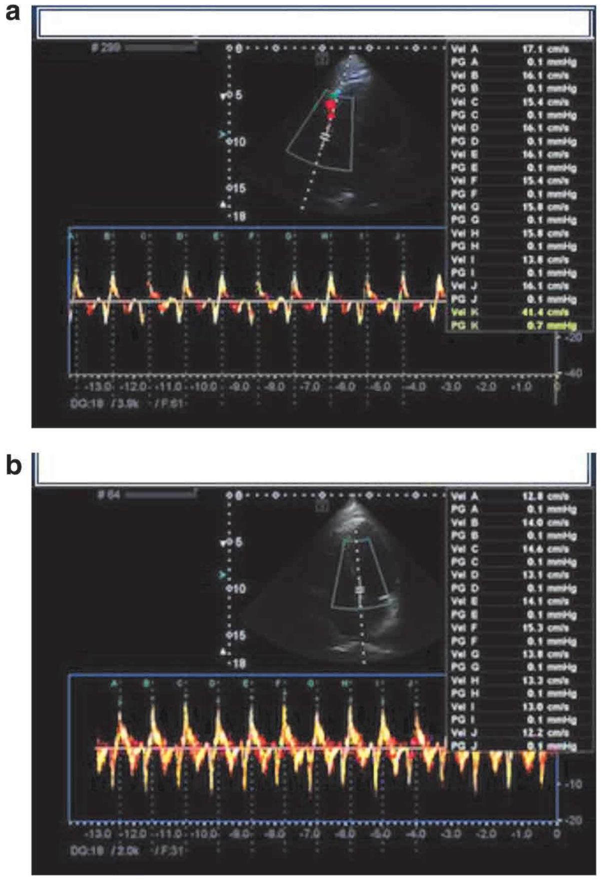

Fig. 46 (abstract 0088). See text for description

0089

Correlation of ultrasound measurement of IVC diameter with CVP and pulmonary artery pressures in mechanically ventilated patients

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INTRODUCTION. Hemodynamic assessment of critically ill patients often involves the implementation of invasive techniques such as the placement of a central venous or a pulmonary artery catheter. Ultrasound measurement of IVC diameter may prove to be a useful, non-invasive alternative method of estimating volume status. Although in spontaneously breathing patients IVC dimensions seem to correlate well with CVP, data concerning mechanically ventilated patients are inconsistent.

OBJECTIVES. The aim of this study was to investigate whether a relationship between IVC diameter and collapsibility, CVP and pulmonary artery pressures exists in patients under mechanical ventilation.

METHODS. We performed a post-hoc analysis of prospectively collected data from 21 mechanically ventilated patients who were admitted to the ICU. A pulmonary artery catheter was inserted to all patients for hemodynamic monitoring and values of CVP, PAS, PAD, PAM were recorded. Ultrasound measurements of IVC diameter at end-expiration and at end-inspiration were made using the subxiphoid approach with the longitudinal plane for IVC imaging (GE LOGIC Q 500 ultrasound machine) and the IVC collapsibility index (IVCI) was calculated using the formula:

([IVCmax - IVCmin]/IVCmax)X100%

All measurements were made during controlled mechanical ventilation with Vt = 8ml/kg, R-R = 12/min and PEEP = 5cmH20.

RESULTS. Data from 21 measurements were statistically analyzed and tested for possible correlation using the Spearmans' Rho test. Significant correlations were found between IVCI and CVP (R = −0.870, p = 0.0001), PAS (R = −0.568, p = 0.007), PAD (R = −0.730, p = 0.0001) and PAM (R = −0.624, p = 0.0024). IVCe was correlated with CVP (R = +0.878, p = 0.0001), PAS (R = +0.579, p = 0.005), PAD (R = +0.650, p = 0.001) and PAM (R = +0.548, p = 0.01).

CONCLUSIONS. Respiratory variations of IVC diameter during mechanical ventilation seem to correlate with CVP as well as with pulmonary artery pressures. Ultrasound measurement of IVC dimensions and collapsibility could be a helpful tool in hemodynamic assessment in mechanically ventilated patients.

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0090

Prediction of fluid responsiveness in heterogeneous ICU-patients: a comparison of passive leg raising PLR, small volume challenge, CVC, $S_{cv}O_2$ and global enddiastolic volume index GEDVI with and without correction for femoral CVC

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INTRODUCTION. Appropriate fluid supply is crucial in critically ill patients. Parameters to predict fluid responsiveness (FR) include variabilities of the arterial pressure curve (e.g. stroke volume variation SVV), filling pressures (e.g. CVP) and volumes such as GEDVI. However, SVV is only applicable in case of sinus rhythm AND controlled Ventilation. The use of GEDVI may be limited due to an overestimation in case of femoral CVC, and filling pressures are confounded by intraabdominal and airway pressures. Therefore, – in case of doubt - a volume challenge VC is recommended as a gold-standard to measure FR. However, the infused volume might be harmful in non-responders. Therefore, passive leg raising PLR has been suggested as a reversible auto-transfusion. Furthermore, small VCs with a limited volume (1–3,5 mL/kg) might replace the standard VC (usually performed with 7mL/kg).

OBJECTIVES. Regarding a lack of studies comparing all these methods in one study, we compared the predictive capabilities of PLR (PLR vs. semi-recumbent-position) to those of CVP, GEDVI with and without correction for femoral CVC (1), $S_{cv}O_2$ and a small VC (SVC) with 3.5mL/kg to a conventional VC with 7mL/kg saline over 30min.

METHODS. 34 VCs with 7mL/kg in 27 patients (11f; 16m) were performed. APACHE-II 22 ± 6. Ventilation: spontaneous 16, assisted 16, controlled 2 patients. CVC jugular 2in 6, femoral in 8 patients. Transpulmonary thermodilution TPTD was performed before PLR, 5 min after PLR immediately before the VC (TPTD_2), after 15min with infusion of 3.5mL/kg (TPTD_3) and at the end of the VC (TPTD_4).

Pulse contour (PC) derived parameters such as CI_PC were documented at intervals of 15s during the PLR and of 5min during the VC.

RESULTS. FR defined as an increase in CI_TPTD_4 of 15% compared to CI_TPTD_1 (primary endpoint) was significantly predicted by a small volume challenge (ROC-AUC = 0.837; p = 0.009), GEDVI corrected for femoral CVC site (ROC-AUC = 0.905; p = 0.002) and $ScvO_2$ (ROC-AUC = 0.772; p = 0.034). By contrast, CVP (ROC-AUC = 0.673; p = 0.176) and percentage changes in CI-PC induced by a 120s PLR (ROC-AUC = 0.619; p = 0.353) were not predictive. Furthermore, GEDV not corrected for femoral CVC site slightly failed significance (ROC-AUC = 0,732; p = 0.057). Furthermore, different other read-outs of PLR such as maximum change in CI_PC during PLR (AUC = 0.551; p = 0.691) as well as changes in CI_PC after 30s (0.626; p = 0.326), 60s (0.667; p = 194) and 90s (0.578; p = 0.542) were not predictive for FR.