Variability of left ventricle outflow tract VTI during breathing cycle may predict fluid responsiveness in the postoperative period for non-cardiac spontaneously breathing patients

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Introduction:
Different studies show controversial results while discussing which echocardiography parameter is the best to assess fluid responsiveness. The aims of the study were to assess diagnostic value of different parameters obtained by focused assessed transthoracic echocardiography (FATE) to control non-cardiac patients' postoperative fluid therapy and to compare infusion therapy plan before and after FATE.

Methods:
The prospective study was carried out in the Anaesthesiology department of Lithuanian University of Health Sciences (LUHS) from the 1st of May to the 1st of September 2016. Eligibility criteria of the patients were: age ≥ 18 years old; the written consent to participate in this study; patients undergoing major abdominal surgery (gastric resection, gastrectomy, liver resection, pancreatic-duodenal resection, colorectal surgery); reduced mean arterial blood pressure up to 30% from the baseline during the first hour post-surgery. The evaluation of fluid responsiveness by clinical signs were defined as urine flow rate less than 0.5 ml/kg/h post-surgery and systolic blood pressure (SBP) increase more than 10 mmHg after fluid challenge. Transthoracic echocardiography was assessed by two trained investigators. The intra- and inter-observer variability of operators for the stroke volume (SV) was 2.5 and 4 %. Positive fluid responsiveness was defined by an increase in SV of at least 15% after the fluid challenge of 500 ml of crystalloids given over 15 minutes. Fluid challenge is stopped when SV is not improving. The following echocardiography data were registered before fluid challenge: mitral E and A waves, E/A ratio, LVOT VTImax and LVOT VTImin during four breathing cycles, IVCmax and IVCmin diameters during breathing cycles. The investigators had no influence on intraoperative fluid management. After post-operative evaluation by FATE fluid management was reconsidered. Responders were continuously monitored by FATE.

Statistics:
Data were analysed using the SPSS 24.0 software. The Kruskal and Wallis tests were used for comparison of data distributions. Nonparametric I‡ 2 test was used for the analysis of nominal qualitative data. The Mann-Whitney U test was used to compare distributions of two samples. A significance level of 0.05 was considered for all tests. A receiver operating characteristic (ROC) curve was used to determine the threshold value of mitral E and A waves, E/A ratio, LVOT VTI
variability, cardiac index (CI) and IVC variations to predict fluid responsiveness, taking into account increase of SV more than 15 %. We defined the area under the curve (AUC) to be clinically relevant if AUC was more than 0.7. For defining success rate of fluid responsiveness by different methods Cochraneâ€™s Q test was used.

To detect the significant difference in mean values of variability of VTI during breathing cycles for responders vs non-responders assuming significance level alpha=0.05 and power of the test=0.8, we should have at least 6 patients in each group.

Results:

Forty patients, 23 (57.5%) men and 17 (42.5%) women, who had reduced MAP 63.4 (Â±7.21) mmHg were included in the study. The mean age of the patients was 60.8 (56.9-64.78) years. Sixteen patients (40%) had ASA physical status II and 24 (60%) had physical status III.

The increase of SV of more than 15 % after volume expansion was found in 12 patients (30%) while increase of SBP more than 10 mmHg occurred only in 6 (15%) patients. The identification of fluid responsiveness by the complex of clinical signs was significantly lower compared to echocardiography data (p=0.034).

Variability of LVOT VTI during breathing cycle was significantly higher in responders compared to non-responders 14 % (Â±5.9) and 6.48 % (Â±12.9), respectively (p=0.001). ROC analysis showed AUC 0.881 (95% CI 0.744 â€“ 1.0, p<0.001), the best cut off value was 10% with 83.3% sensitivity and 85.7% specificity.

The mitral E wave velocity was 72.14 cm/s (Â±14.5) in responders compared to 89.7 cm/s (Â±17.2) in non-responders. ROC analysis showed AUC was 0.78 (95% CI 0.619 â€“ 0.941, p=0.006), the best cut off value was 78.5 with 75 % sensitivity and 82.1 % specificity. The increase of mitral E wave after fluid challenge was bigger in responders compared to non-responders 9.28 cm/s (Â±5.9) and 2.64 cm/s (Â±2.84) (p=0.003). Calculation of â€œE is suitable parameter to predict fluid responsiveness as AUC under the ROC curve was 0.893 (95% CI 0.794 â€“ 0.992, p p<0.001). The Increase of E wave more than 4 cm/s can predict fluid responsiveness with sensitivity of 91.7 % and specificity of 78.6%. The similar results were with A/E ratio: mean E/A ratio in responders was 0.87 (SD 0.096) and in non-responders 1.086 (Â±0.16), AUC was 0.868 (95% CI 0.755 â€“ 0.98, p<0.001), the best cut off value 0.913 with 75 % sensitivity and 89.3 % specificity. The increase of E/A ratio after fluid bolus was bigger in responders compared to non-responders 0.07 (Â±0.02) and 0.04 (Â±0.008) respectively (p=0.001). The AUC under the ROC curve was 0.878 (95% CI 0.76 â€“ 0.995, p p<0.001). The Increase of E/A ratio more than 0.07 can predict fluid responsiveness with sensitivity of 83.3 % and specificity of 85.7%.

Although cardiac index was lower in responders 2.89 L/min/m2 (Â±1.06) compared to non-responders 3.35 L/min/m2 (Â±0.94) the difference was not significant (p=0.214). According to ROC analysis AUC was 0.622 (95% CI 0.424 â€“ 0.82, p=0.82). CI seemed to be not suitable for prognosis of fluid responsiveness.

The variability of IVC was significantly higher in responders 32.29 % (Â±13.48) compared to 11.03 % (Â±12.24) in non-responders (p<0.001). The AUC of the ROC curve for IVC variability index was 0.878 (95% CI 0.768 â€“ 0.988, p<0.001) and the best cut off value seemed to be 26.6 % with 75 % sensitivity and 82.8 % specificity.
There was no difference between infusion therapy in responders and non-responders during operation 2167 (Â±961) ml and 1678 (Â±676) ml (p=0.13) respectively. Before the evaluation by FATE planed postoperative fluid therapy was also similar for responders and non-responders 1500 (Â±522) ml and 1678 (Â±564) ml respectively (p=0.344). The infusion therapy for non-responders was reduced in average up to 982 (Â±120) ml from the primary plan 1678 (Â± 564) which was before the assessment by FATE (p=0.01).

Conclusions.

LVOT VTI variability of more than 10% in spontaneously breathing patients had the highest sensitivity and comparable specificity among the parameters used for identification of fluid responders by FATE. Perioperative focused ultrasound monitoring reduce excessive infusion therapy compared to standard monitoring.