Deve Confiar-se no Exame Ecográfico da Veia Cava Inferior para Avaliar a Resposta a Fluidos em Voluntários ASA 1 e 2?

Should Echographic Examination of the Inferior Vena Cava be Trusted to Assess Fluid Responsiveness in ASA 1 and 2 Volunteers?

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Resumo

Introdução: A resposta a fluidos endovenosos é um conceito fundamental na abordagem da fluidoterapia perioperatória, integrando a maioria dos protocolos de fluidoterapia dirigida por objectivos (goal-directed therapy). Pode ser avaliada de modo não invasivo utilizando ecocardiografia transtorácica, nomeadamente medindo a variação do integral de velocidade-tempo transaórtico com a manobra de elevação passiva dos membros inferiores (ΔVTIAo PLR). Este é o parâmetro ecocardiográfico mais validado em pacientes sob ventilação espontânea, mas outros autores sugerem a avaliação da veia cava inferior (VCI) com esse propósito.

Métodos: Estudo observacional, analítico, prospectivo, em voluntários ASA 1 e ASA 2, em ventilação espontânea, sem comorbilidades cardiovasculares. A relação entre os índices da VCI e a ΔVTIAo PLR foi inicialmente estudada através do coeficiente de correlação de Pearson. Os indivíduos foram então estratificados de acordo com as guidelines da ASE/EAE para avaliação da VCI, e a distribuição de ΔVTIAo PLR entre cada subgrupo comparada com o teste de Kruskal-Wallis (três subgrupos) e o teste de Mann-Whitney (comparando apenas os dois subgrupos em extremos opostos).

Resultados: Não se verificou relação estatisticamente significativa entre os parâmetros da VCI e a ΔVTIAo PLR (p value 0.920 para o diâmetro da VCI e p = 0.248 para o índice de colapsabilidade da VCI). Também não se verificou diferença estatisticamente significativa na resposta a fluidos endovenosos entre subgrupos com diferentes características da VCI (p = 0.081 para teste de Kruskal-Wallis; p = 0.858 para teste de Mann-Whitney 0.858).

Conclusões: A avaliação da VCI por ecocardiografia transtorácica não se revelou adequada para avaliar a resposta a fluidos em indivíduos ASA 1 e ASA 2 sob ventilação espontânea. À luz dos resultados obtidos sugere-se cautela na utilização de índices da VCI para guiar a fluidoterapia em pacientes não críticos sob ventilação espontânea.

Palavras-chave: Fluidoterapia; Ultrassonografia; Veia Cava Inferior

Abstract

Introduction: Fluid responsiveness is a fundamental concept in the management of perioperative fluid therapy, and an integrating part of most goal-directed therapy protocols. It can be assessed non-invasively by transthoracic echocardiography, namely by measurement of transaortic velocity time integral variation with the passive leg raise manoeuvre (ΔVTIAo PLR). This is the most validated echocardiographic parameter in spontaneously breathing individuals, but other authors suggest using inferior vena cava (IVC) assessment with the same goal.

Methods: Observational, analytic, prospective study in ASA 1 and ASA 2 spontaneously breathing volunteers, with no cardiovascular comorbidities. The relationship between isolated IVC indices and ΔVTIAo PLR was initially studied using Pearson’s correlation coefficient. Individuals were then stratified according to ASE/EAE guidelines for IVC evaluation, and the distribution of ΔVTIAo PLR within each subgroup compared with a Kruskal-Wallis test (comparing all three subgroups) and a Mann-Whitney test (comparing only the subgroups at the opposite ends of the spectrum).

Results: There was no statistically significant relationship between isolated echocardiographic IVC parameters and ΔVTIAo PLR (p value 0.920 for IVC diameter and 0.248 for IVC collapsibility index). There was also no statistically significant difference in fluid responsiveness between subgroups with different IVC characteristics (Kruskal-Wallis test’s p value 0.081; Mann-Whitney test’s p value 0.858).

Conclusions: IVC assessment through transthoracic echocardiography did not prove adequate for assessment of fluid status and fluid responsiveness in ASA 1 and ASA 2 spontaneously breathing individuals. In view of our results caution is advised when relying on IVC indices to guide fluid therapy in non-critical, spontaneously breathing patients.

Keywords: Fluid Therapy; Ultrasonography; Vena Cava, Inferior
INTRODUCTION

In the perioperative period there is often a disruption in patients’ homeostasis, with the use of the different drugs and/or interventions routinely altering their preload, contractility, chronotropism and afterload. With the intent of maximizing benefits while at the same time minimizing the possibility of harm, up until a few years ago there was a strong emphasis on fluid loading patients during anaesthesia (provided there were no obvious contraindications nor signs of overload), so as to optimize their cardiovascular state according to the Frank-Starling law. However, while such was believed to minimize intraoperative decompensation, more recent studies have shown that excessive fluid replenishment can actually be deleterious, and it became necessary to rethink the concept and find ways to better assess the true haemodynamic state of patients on an individual basis. Goal-directed therapy approaches strive to do precisely that, usually by classifying individuals according to their position either on the ascending or flat limbs of the Frank-Starling curve. Their implementation has produced favourable outcomes, but assessing fluid responsiveness is not always easy. Central venous pressure (CVP) measurements are now known to be unreliable markers for the haemodynamic state of the patient, and consequently different technologies have evolved to replace it, many of which rely on the analysis of respiratory variations in pulse pressure and systolic pressure were also suggested, though presently their use is only validated for ventilated patients. Furthermore, all of these technologies are invasive, and thus not appropriate for simpler patients proposed for minor operations, not meriting such monitoring devices. More recently, echocardiography has been emerging as a simple, bedside alternative to assess the haemodynamic status of patients noninvasively, and is growingly being used by anaesthesiologists and intensive care physicians worldwide. At the present, and for patients breathing spontaneously, the most validated echocardiographic marker of fluid responsiveness is transaortic velocity time integral variation with the passive leg raise manoeuvre (ΔVTIA_o PLR). Other authors preconize the use of inferior vena cava (IVC) assessment combining both its diameter and inspiratory collapsibility index. The European Association of Echocardiography (part of the European Association of Cardiovascular Imaging), however, considers the assessment of the IVC as a means to estimate the pressure in the right atrium (i.e., as a means to assess CVP) which, as we previously mentioned, is not an adequate marker for fluid responsiveness. Given the importance of the subject and that these indices are relied on for important patient management decisions, the authors decided to evaluate whether assessment of the IVC is indeed reliable as an index of fluid responsiveness under spontaneous ventilation.

MATERIAL AND METHODS

After obtaining approval by the local Ethics Commission and informed consent from each participant, we performed an observational, prospective study in 31 spontaneously breathing ASA 1 and ASA 2 individuals, without cardiovascular comorbidities. Table 1 summarizes inclusion and exclusion criteria adopted.

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<th>INCLUSION CRITERIA</th>
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<td>• Adult, legally competent adults</td>
<td>• Failure to provide informed consent</td>
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<td>• ASA 1 or ASA 2</td>
<td>• Inability to withstand proper positioning</td>
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<td>• Cardiovascular disease or medication</td>
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<td>• Inadequate echocardiographic images</td>
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Any pre-existing echocardiographic anomalies were excluded by a screening scan, and data on echocardiographic parameters were then collected in two separate examinations per volunteer on separate days, namely:

- Expiratory diameter of the IVC (Dexp IVC);
- Respiratory variation (collapsibility index) of IVC (Δresp IVC);
- Transaortic velocity time integral (VTIA_o) variation with the passive leg raise manoeuvre (PLR) (ΔVTIA_o PLR) – considered as the gold-standard, and used for comparison purposes.

Additional data were also collected and used in satellite studies, previously published, and as such will not be considered here.

All scans were performed by the same operator so as to decrease variability, using the same GE Vivid 7™ echocardiograph, and later analysed off-line in a random order with the software suite EchoPAC Dimension™, in a process reviewed by an independent observer. The data obtained were then used to build a database in SPSS Statistics™ version 23, and tested for the existence of linear correlation between both types of preload indices (IVC assessment and ΔVTIA_o PLR) using both Pearson’s correlation coefficient and scatter plots. Because this analysis only tested for correlation between isolated IVC indices and fluid responsiveness, not taking into account the possible combined effects of IVC diameter and collapsibility index, we then decided to divide the sample into different classes according to internationally recognized cut-offs for IVC indices, as follows:
Should IVC expiratory diameter and collapsibility index in combination signal fluid responsiveness, then volunteers in each of the subgroups would differ in ΔVTIA_o PLR, which we assessed using the Kruskal-Wallis test (due to the existence of three different subgroups). Finally, because subgroup three included individuals not belonging to either of the traditional subgroups 1 and 2, and as such had a somewhat indeterminate behaviour in terms of fluid responsiveness in the literature, we decided to additionally compare subgroups 1 and 2 against each other in isolation, excluding individuals from subgroup 3 from the analysis, as they might introduce bias. To do so, we performed a Mann-Whitney test.

RESULTS

SAMPLE CHARACTERISTICS

Table 2 summarizes the characteristics of the sample. Forty-eight percent of the volunteers were male, and 71% of the total ASA 2, though without cardiac comorbidities. Existing comorbidities were either respiratory (controlled asthma, with no crisis for over a month and no current medication; smoking) or metabolic (excess weight - BMI 25-29.9 kg/m², dyslipidaemia).

Table 2. Sample characteristics

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<tr>
<th>VARIABLE</th>
<th>SAMPL CHARACTERISTICS</th>
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<tr>
<td>Age</td>
<td>Average of 37 years old (ranging from 26 to 67)</td>
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<tr>
<td>Sex</td>
<td>• 15 male volunteers</td>
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<tr>
<td></td>
<td>• 16 female volunteers</td>
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<tr>
<td>ASA Physical Status classification</td>
<td>• ASA 1: 22 volunteers</td>
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<td>• ASA 2: 9 volunteers</td>
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EXPIRATORY DIAMETER OF THE IVC (Dexp IVC)

There was no statistically significant linear correlation between the absolute expiratory dimensions of IVC and ΔVTIA_o PLR (our gold-standard for fluid responsiveness) (Fig. 1, Table 3), with Pearson’s correlation coefficient exhibiting a $p$ value of 0.920.

RESPIRATORY VARIATION OF IVC DIAMETER (Δresp IVC) (COLLAPSIBILITY INDEX)

There was no statistically significant linear correlation between collapsibility index of the IVC and the gold-standard (ΔVTIA_o PLR) (Fig. 2, Table 3), with Pearson’s correlation coefficient exhibiting a $p$ value of 0.248.
CONCLUSION

IVC assessment through transthoracic echocardiography was not adequate for assessment of fluid status and fluid responsiveness in ASA 1 and 2 spontaneously ventilating volunteers. In view of our results caution is advised when relying on IVC indices to guide fluid therapy in non-critical, spontaneously breathing individuals. Further, larger trials are needed as it is not possible to guarantee that these results hold true in other patient groups.

ACKNOWLEDGEMENTS

The author would like to express his gratitude towards all of the volunteers who enthusiastically and selflessly participated in the study, as well as to the professionals of the Echocardiography Laboratory at Santa Cruz Hospital in Lisbon, where the study took place, and to the Anaesthesiology Service of Centro Hospitalar de Lisboa Ocidental (Lisbon, Portugal), for their unwavering support.

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