

Tracking Intravascular Volume Using Frequency Analysis of Peripheral Venous Pressure Waveforms

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Background: Mean arterial pressure (MAP) and central venous pressure (CVP) are both commonly used parameters in guiding fluid resuscitation. Central venous pressure measurement however, is invasive to monitor and not possible in every situation. Peripheral venous pressures are easy to obtain in ubiquitous peripheral IV lines. In this study, we investigate the use of peripheral venous pressure (PVP) as a less invasive alternative to CVP. Prior studies have shown a strong correlation between PVP and CVP during the intraoperative period (1). The aim of this study is to compare changes in MAP and PVP waveform utilizing frequency analysis, prior and after resuscitation during pediatric spinal fusion surgery for scoliosis, a procedure with substantial blood loss requiring resuscitation (2). Frequency domain analysis of PVP was chosen as it is less prone to artifact than time domain analysis (3).

Methods: With IRB approval, 32 children undergoing spinal fusion were studied. EKG, blood pressure, invasive arterial pressure, peripheral venous pressure, and airway pressure were recorded at 100 Hz with a data acquisition system (Collect 5/S, GE) and analyzed using frequency analysis (spectrum, 4K, Hamming, Amplitude density) with LabChart 7 (ADInstruments). Amplitude density of the graph at the respiratory frequency is defined as the PVP DC value. Normalizing this against an internal control of the amplitude density at the cardiac frequency yielded the PVP DC% values to allow comparison between patients (figure 1a). Mean PVP was obtained from the peripheral venous pressure waveform. Data were analyzed before resuscitation and after resuscitation (fluid, blood, or albumin) with some patients yielding multiple data points. A total of 47 data points was obtained. Normality was checked using Shapiro-Wilk ($p < 0.05$). Paired t-test or Wilcoxon signed-rank test was used for parametric or non-parametric data, respectively. Statistical analyses were conducted using SPSS version 26.

Results: Resuscitation was associated with a greater change in PVP DC %, than MAP. PVP DC % reached statistical significance. (figure 1b-c)

Discussion: Frequency domain analysis of PVP waveforms showed a greater change after fluid resuscitation as compared to MAP, suggesting its potential use for fluid therapy and resuscitation.

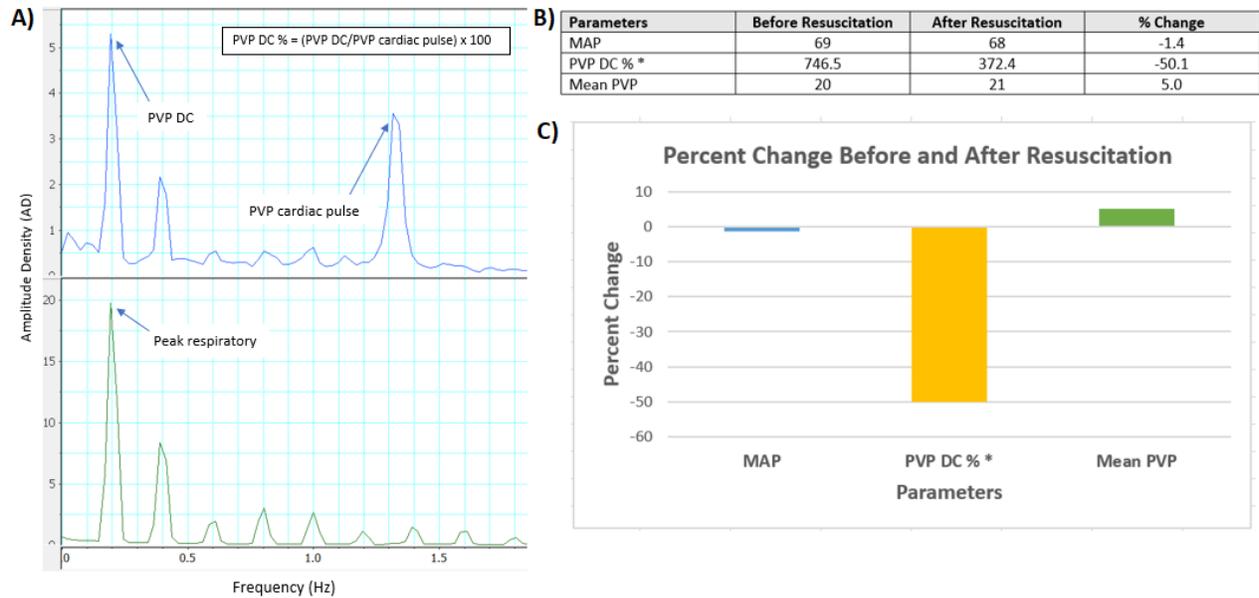


Figure 1: A) Frequency analysis of PVP waveform. B-C) Percent change in MAP, PVP DC%, and Mean PVP before and after resuscitation. *statistical significance ($p < 0.05$)

References:

1. J Cardiothorac Vasc Anesth. 2001;15-40-43.
2. Spine 2014;39:1479–87.
3. Anesth Analg 2013;117:1380–92.