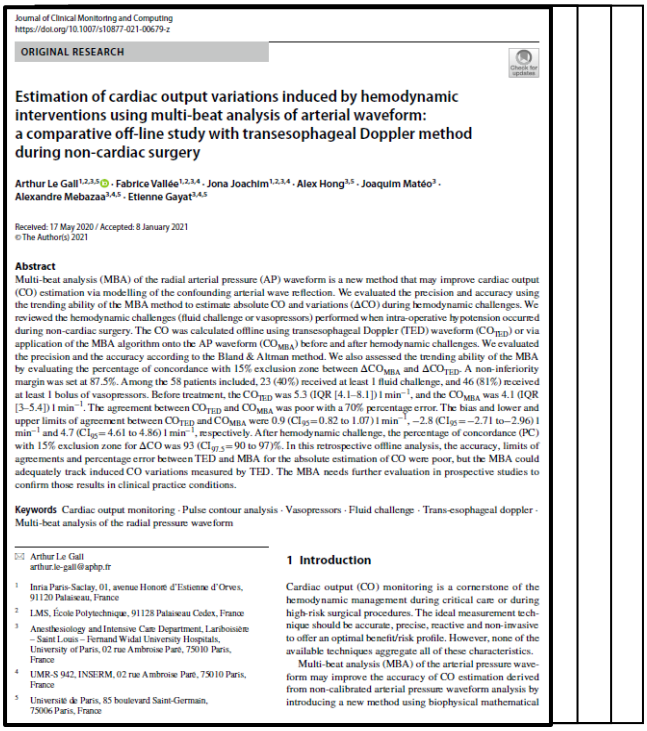
MBA™ Algorithm Shows High Accuracy in Tracking Relative Changes in CO Compared to Transesophageal Doppler



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ORIGINAL RESEARCH

Estimation of cardiac output variations induced by hemodynamic interventions using multi-beat analysis of arterial waveform: a comparative off-line study with transesophageal Doppler method during non-cardiac surgery

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Abstract
Multi-beat analysis (MBA) of the radial arterial pressure (AP) waveform is a new method that may improve cardiac output (CO) estimation via modelling of the confounding arterial wave reflection. We evaluated the precision and accuracy using the trending ability of the MBA method to estimate absolute CO and variations (ΔCO) during hemodynamic challenges. We reviewed the hemodynamic challenges (fluid challenge or vasopressors) performed when intra-operative hypotension occurred during non-cardiac surgery. The CO was calculated offline using transesophageal Doppler (TED) waveform (CO_{TED}) or via application of the MBA algorithm onto the AP waveform (CO_{MBA}) before and after hemodynamic challenges. We evaluated the precision and the accuracy according to the Bland & Altman method. We also assessed the trending ability of the MBA by evaluating the percentage of concordance with 15% exclusion zone between ΔCO_{MBA} and ΔCO_{TED}. A non-inferiority margin was set at 87.5%. Among the 58 patients included, 23 (40%) received at least 1 fluid challenge, and 46 (81%) received at least 1 bolus of vasopressors. Before treatment, the CO_{TED} was 5.3 (IQR [4.1–8.1]) l min^{-1}, and the CO_{MBA} was 4.1 (IQR [3–5.4]) l min^{-1}. The agreement between CO_{TED} and CO_{MBA} was poor with a 70% percentage error. The bias and lower and upper limits of agreement between CO_{TED} and CO_{MBA} were 0.9 (CI_{95} = 0.82 to 1.07) l min^{-1}, −2.8 (CI_{95} = −2.71 to−2.96) l min^{-1} and 4.7 (CI_{95} = 4.61 to 4.86) l min^{-1}, respectively. After hemodynamic challenge, the percentage of concordance (PC) with 15% exclusion zone for ΔCO was 93 ($CI_{97.5}$ = 90 to 97)%. In this retrospective offline analysis, the accuracy, limits of agreements and percentage error between TED and MBA for the absolute estimation of CO were poor, but the MBA could adequately track induced CO variations measured by TED. The MBA needs further evaluation in prospective studies to confirm those results in clinical practice conditions.

Keywords Cardiac output monitoring · Pulse contour analysis · Vasopressors · Fluid challenge · Trans-esophageal doppler · Multi-beat analysis of the radial pressure waveform

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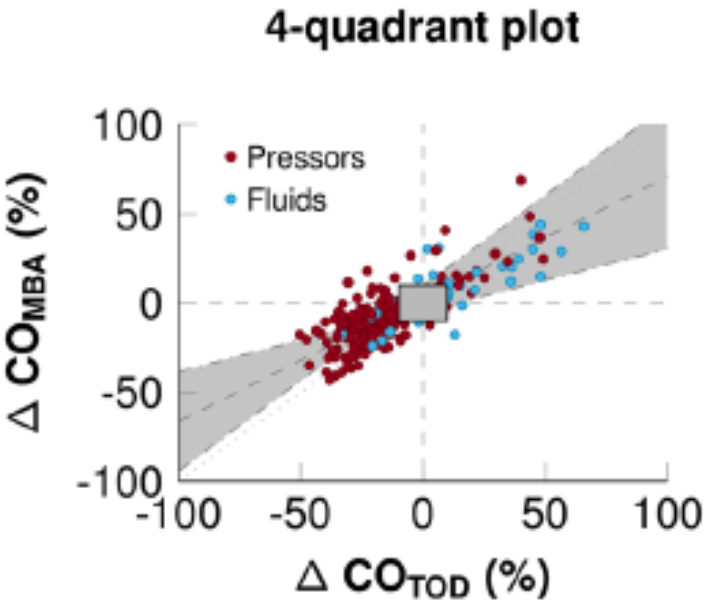
1 Introduction

Cardiac output (CO) monitoring is a cornerstone of the hemodynamic management during critical care or during high-risk surgical procedures. The ideal measurement technique should be accurate, precise, reactive and non-invasive to offer an optimal benefit/risk profile. However, none of the available techniques aggregate all of these characteristics.

Multi-beat analysis (MBA) of the arterial pressure waveform may improve the accuracy of CO estimation derived from non-calibrated arterial pressure waveform analysis by introducing a new method using biophysical mathematical



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- *n = 58 (neurosurgical and abdominal surgical patients)*
  - 255 interventions analyzed
  - 40% received at least one fluid challenge
  - 81% received at least 1 bolus of vasopressors
- Primary Endpoint: Concordance for relative changes in CO between the MBA method and Transesophageal Doppler (TED)
- The MBA method was similar to the TED method when estimating variations in CO caused by hemodynamic challenges even when vasopressors were used
- After various hemodynamic challenges (fluids and vasopressors), the MBA algorithm agreed with TED (concordance) in tracking CO changes 93% of the time

Other hemodynamic monitoring technologies based on pulse contour analysis have had difficulties tracking cardiac output changes in response to vasopressor intervention

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