Ultrasound-based monitoring of cardiac output after off-pump coronary artery bypass grafting

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Background

Recently, USCOM technique (Ultrasound Cardiac Output Monitor), using advanced Doppler method to assess cardiac output (CO), has become clinically available. However, this technique requires validation in different categories of patients. The aim of our study was to evaluate the accuracy of USCOM compared to prepulmonary thermodilution in patients after off-pump coronary artery bypass grafting (OPCAB).

Methods

We enrolled 33 patients who underwent elective OPCAB into an ongoing prospective observational study. The measurements of cardiac index (CI) based on USCOM (CI_{USCOM}) and CI determined by thermodilution using pulmonary artery catheter (CI_{TD}) were performed at seven stages during postoperative period. We calculated Spearman's ρ coefficient to assess the correlation between CI_{USCOM} and CI_{TD} . The agreement between methods was evaluated using Bland-Altman analysis with percentage error calculation using overall pairs of data and separately during mechanical ventilation (4 stages) and after tracheal extubation (3 stages). Additionally, we evaluated trending ability using four-quadrant plot and concordance index based on overall data and separately during mechanical ventilation and after tracheal extubation.

Fig.1

Fig.2

Fig.1

Bland – Altman plots for cardiac index determined with USCOM and prepulmonary thermodilution during mechanical ventilation (A) and after tracheal extubation (B).

The *continuous horizontal line* indicates the value for the average difference between CI_{USCOM} and CI_{TD} .

The *dashed horizontal lines* indicate the upper and lower 95% limits of agreement.

CI_{USCOM} – cardiac index measured using USCOM, CI_{TD} – cardiac index measured using prepulmonary thermodilution, SD – standard deviation.

Fig.2

Four-quadrant plot representing the ability of USCOM to track changes in cardiac index during mechanical ventilation (A) and after tracheal extubation (B).

Gray square represents central exclusion zone of $\Delta CI < 10\%$.

ΔCI_{USCOM} – change in cardiac index measured by USCOM, ΔCI_{TD} – change in cardiac index measured by prepulmonary thermodilution.

Results

Totally, 231 pairs of data were collected. We found significant correlation between CI_{USCOM} and CI_{TD} in overall data ($\rho = 0.53$, $p < 0.01$) and during mechanical ventilation ($\rho = 0.57$, $p < 0.01$), but there was no correlation during spontaneous breathing ($\rho = 0.371$, $p = 0.79$). Bland–Altman analysis revealed bias between CI_{USCOM} and CI_{TD} of -1.07 L/min/m² with limits of agreement of ± 1.40 L/min/m² and percentage error of 72%. The subgroup assessment found better between the method agreement during mechanical ventilation compared to stages after tracheal extubation (Fig. 1) with percentage error of 80% and 61%, respectively. Trending analysis revealed overall concordance of 81%. The subgroup analysis also showed better trending ability of USCOM during mechanical ventilation (Fig. 2).

Conclusions

Despite significant correlation between CI_{USCOM} and CI_{TD} during mechanical ventilation after off-pump coronary surgery, USCOM demonstrates poor accuracy with underestimation of CI, as well as low trending ability compared to thermodilution technique both before and after tracheal extubation.