A volume buffer capacity device dynamically reduces excessive venous line pressure and arterial gaseous embolic load during minimized cardiopulmonary bypass

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In the January 2014 issue of the journal, we read the interesting article of Aboud et al., in which they describe a comparison of miniaturized versus conventional open cardiopulmonary bypass regarding venous line pressure, gaseous microemboli (GME), biochemical parameters of systemic inflammatory response, ischaemia, haemodilution and haemolysis [1]. Among other findings, they found predominantly long-lasting and severely low pressures in the venous line and right atrium, as well as a significantly higher GME activity in the miniaturized cardiopulmonary bypass group. Furthermore, they found low venous line pressure to be accompanied by arterial and venous air bubbles >500 μm in diameter.

A comparable study previously published by our group comparing standard closed cardiopulmonary bypass with two different types of miniaturized circuits showed similar results [2]. Although we could not trace such large arterial air bubbles as Aboud et al. did, we found excessive subatmospheric drainage pressures to significantly correlate with arterial GME activity (Pearson’s correlation factor –0.35), whereas bubble activity proved near-absent in the group using the standard closed circuit. Moreover, in some cases, we found arterial cumulative GME volume to be larger than venous volume and hypothesized de novo microbubble formation induced by in-pump degassing to be the cause of the increase in GME volume. This was confirmed in two sequential studies showing that impeded drainage resulted in arterial GME, while the venous line was GME-free [3, 4]. We therefore emphasize that excessively low venous drainage pressures should be prevented and that both miniaturized systems and managing those require further refinement.

Aboud et al. mention distinctive sources for ‘in-circuit air’ that eventually lead to arterial GME. One is entrainment at the cannulation site, or as Zanatta et al. [5] showed, GME-contaminated fluids infused via a central venous line. A combination of entrainment and infusion might explain the relatively high amount of venous and arterial GME >500 μm found by Aboud et al., although one would expect the oxygenator and arterial filter to eliminate such large bubbles. Another source of arterial GME can be degassing of blood-dissolved gasses inside the centrifugal pump, which occurs when venous line pressure peaks down to excessively low subatmospheric values during so-called ‘venous line chattering’. In that context, a passive volume buffer capacity device (BigBetterBladder, Circulatory Technologies, Inc., Oyster Bay, NY, USA) inserted into the venous line has shown to result in a 14% increase in average support, a 40% decrease in fluctuations of venous line pressure and an 85% reduction in GME [2, 4]. A volume buffer capacity device added to the venous line in systems that directly drain from the right atrium should therefore be considered a mandatory rather than optional safety feature.

We are grateful to Aboud et al. for sharing their experience and knowledge and for highlighting the fact that evident benefits of mini-perfusion systems do not come without consequences.

REFERENCES


