

**Tips and Tricks for Volume Management in relation to Central Venous Pressure (CVP) in Minimally Invasive Extracorporeal Circulation (MiECC) Population.**

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## Background

In cardiac surgery, veno-dilation occurs shortly after the institution of cardiopulmonary bypass (CPB), necessitating fluid or vasoconstrictor administration to maintain adequate oxygen delivery. This phenomenon is highlighted in conventional CPB by the presence of the venous reservoir, which allows for the visualization of the dynamic volume during cardiac surgery. procedures and to visually perceive the veno-dilation phenomenon. The literature provides some consideration of central-venous pressure (CVP); in particular, any given CVP value will not accurately predict whether a patient will respond to fluids. This is true for all variables, including cardiac output, capillary refill time, central venous oxygen saturation, urine output, and blood lactate level. Nevertheless, when the CVP is low, there is a greater chance of an increase in cardiac output in response to fluids. In this context, we found some analogies of fluid management in relation to CVP during minimally invasive extracorporeal circulation (MIECC) techniques in particular for closed systems without the dynamic vision of venous volume in a hards-hell or soft-shell reservoir. This aspect is connected not only to the types of circuit, hardware, and safety systems of the console but also to the “tricks” and strategies of the perfusion operator and anesthetist during the procedures.

## Methods

At our institution, 50 adults were scheduled for isolated elective coronary artery bypass grafting with MIECC volume management (type III). Baseline characteristics are reported in Table 1. Patients analyzed in this context were not critical, did not have endocarditis or septic shock, and reported good preoperative hemodynamical stability without the use of diuretics and Swan-Ganz catheter. Anesthesia was induced with intravenous sufentanil (0.5 to 1  $\mu\text{g}/\text{kg}$ ) and midazolam (0.08 to 0.2 mg/kg), and tracheal intubation was facilitated with intravenous rocuronium (0.6 to 1 mg/kg). Anesthesia was maintained with propofol (2 to 5 mg/kg) and sufentanil (0.5 to 2.0  $\mu\text{g}/\text{kg}$ ), and the depth of anesthesia was monitored using bispectral index (BIS) values (BIS XP, Aspect Medical System, Newton, MA, USA). The dosage of propofol was titrated to maintain BIS values between 40 and 45. Normothermic blood cardioplegia (St Thomas solution) was used in all cases and repeated every 20 min. Oxygen delivery was calculated as follows: cardiac output  $\times$  arterial oxygen concentration  $\times$  10. During the cross-clamp time, we observed and collected the CVP values and correlations for various situations for including blood flow, inlet of pump pressure, cardiac cavities (stretched or empty), and mean arterial pressure with solutions correlation and volume management strategies for ideal CVP (3 to 5 mm Hg).

## **Results**

We share our approach for volume management (Table 2). During MIECC type III, we used a central cannulation with a single atrio caval cannula 32/40 Fr for the right atrium and 22 to 24 Fr arterial cannula for the ascending aorta (Fig. 1). Nevertheless, in the literature, there are no clear CVP nadirs on MIECC for volume management. Table 2 describes our approach to volume management in relation to CVP.

## **Conclusion**

Our experience reported that tips and tricks for CVP nadirs between (3-5 mmHg) were effective for volume management in MIECC Type III. Nevertheless, further studies are needed to support the CVP nadirs during the MIECC approach.

## Tables

**Table I.** Clinical Characteristics of the Study Group.

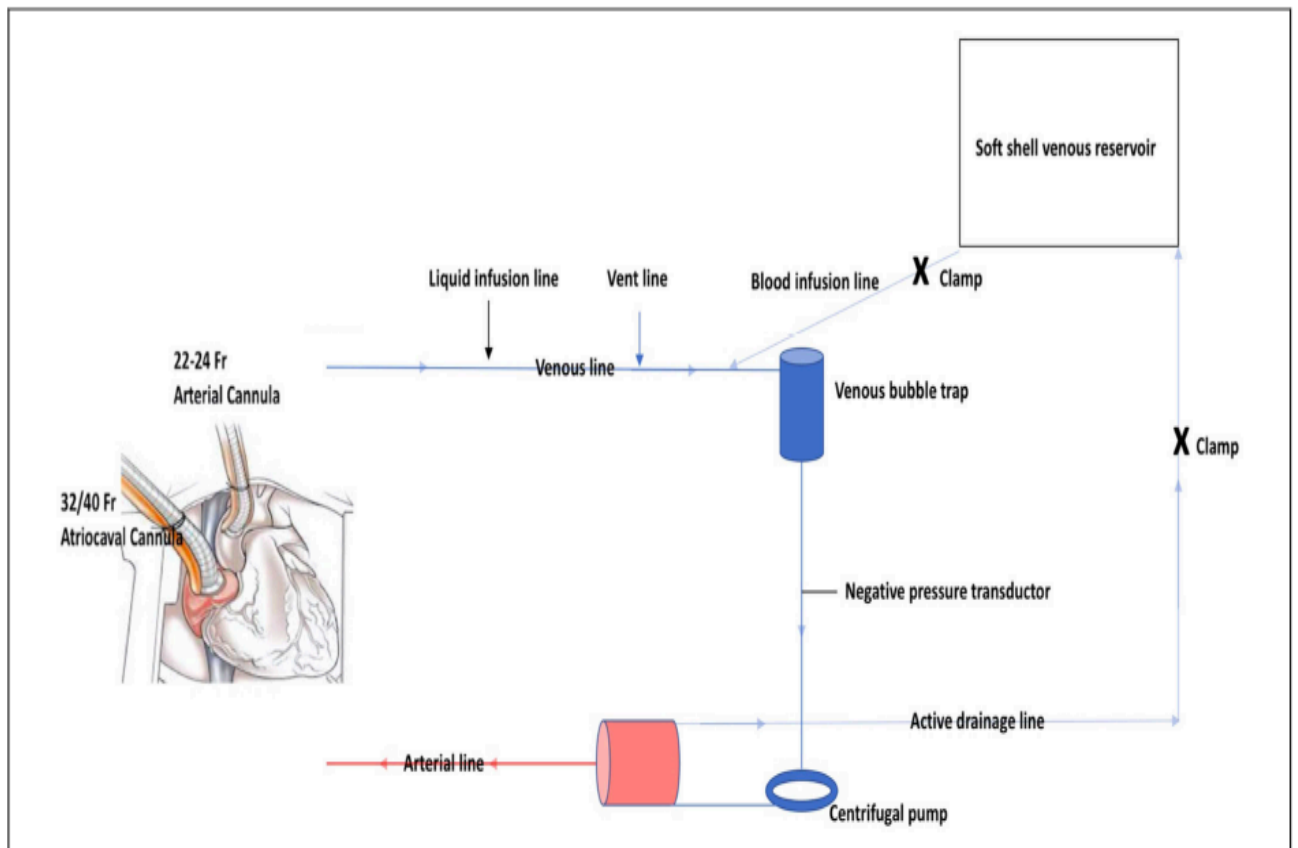
	MIECC (N = 50)
Mean age, years	72.0 (63.7)
Body surface area, m <sup>2</sup>	1.85
Median NYHA class	2
EuroSCORE II	1.5
Mean ± SEM pre-CPB hematocrit, %	34.6 ± 1.3
Pre-CPB hemoglobin, g/dl	11.4 ± 1.1
CPB time, min	63 ± 15.2
Aortic cross-clamp time, min	47 ± 9

Abbreviations: CPB, cardiopulmonary bypass; EuroSCORE, European System for Cardiac Operative Risk Evaluation; MIECC, minimally invasive extracorporeal circulation; NYHA, New York Heart Association; SEM, standard error of the mean.

**Table 2.** Situations and Solutions for Volume Management During MIECC Technologies.

	Situation	Solution
CVP 3 to 5 mm Hg Collected on 25 MIECC type III	Optimal blood flow Empty cavities MAP 50 to 70 mm Hg	Maintaining the parameters
CVP >5 mm Hg Collected on 5 MIECC type III	Low blood flow Cavities stretched on TEE monitoring with cannula cavitation (negative pressure in inlet pump) MAP <50 mm Hg	First: reducing pump revolutions (RPM) Second: reposition of the venous cannula with TEE monitoring Third: nadir (CVP 3 to 5 mm Hg), increase pump revolutions (RPM)
CVP >5 mm Hg Collected on 12 MIECC type III	Optimal blood flow Cavities stretched MAP >70 mm Hg	Active drainage in softshell venous reservoir And/or vasodilatation use Nadir (CVP 3 to 5 mm Hg)
CVP -1/2 Collected on 8 MIECC type III	Low flow Cavitation (negative pressure in venous line) Cavities empty MAP <50 mm Hg	First: reducing pump revolutions (RPM) Second: Trendelenburg position Third: adding liquids or vasoconstrictor use Fourth: nadir CVP (3 to 5 mm Hg), increase pump revolutions (RPM)

Abbreviations: CVP, central venous pressure; MAP, mean arterial pressure; MIECC, minimally invasive extracorporeal circulation; TEE, transesophageal echocardiography.



**Fig. 1.** Minimally invasive extracorporeal circulation type III sketch.