EDITORIAL

Awake Extracorporeal Membrane Oxygenation: A Magic Bullet?

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The case report by Pooja et al. emphasizes the importance of "awake" ECMO strategy to improve outcomes. This technique has underlined the importance of minimalistic approach as a key to early recovery. One of the dreaded complications of long-stay patients in intensive care unit (ICU) requiring invasive mechanical ventilation is susceptibility to hospital-acquired infections thereby increasing mortality and morbidity. Other significant side effects are delirium, added effects of sedation, diaphragmatic weakness, and ICU acquired weakness.

The pertinent issues of "awake" ECMO on initiation, monitoring, and management can be made fruitful if one takes into account the complex patient machine interaction, effects of pathological condition on various organ systems, and organ to organ interaction. These important aspects should be contemplated while considering the cannula selection, appropriate ECMO settings, and monitoring aspects to yield optimal results.

Technical Considerations

Veno-venous ECMO cannulation can be done with two techniques:

- Single-site bicaval bilumen catheters.
- Dual-site cannulae (femoro-jugular and femoro-femoral).

Each technique has its set of advantages and disadvantages; single-site cannulas have the advantage of ensuring free femoral area thereby facilitating mobility and physiotherapy. These single-site cannulas are less affected by wide swings in intra-abdominal pressure causing shunting of blood from inferior vena cava (IVC) to superior vena cava (SVC) translating to lesser incidence of flow fluctuations. The disadvantage of single-site cannula being a large cannula, this warrants meticulous attention during insertion requiring echocardiography/fluoroscopy assistance for precise placement. These cannulae are more prone to iatrogenic complications like bleeding, pneumothorax, and ventricular rupture. Considering the difficulty of cannula insertion, especially in spontaneously breathing subjects with respiratory failure, this might warrant anesthesia and mechanical ventilation to create ideal conditions. Dual-site cannulae are easier to insert requiring light sedation. However, as access is through femoral vein, this causes impediment to mobilization, increased incidence of central-line associated blood stream infections, and prone to shunting effects of IVC to SVC secondary to increased intra-abdominal pressure[1] (Figs 1 to 5).

Of late there have been improvements in the equipment for cannulation and ECMO operation. To name a few, Garcia et al. advocated using jugular bicaval double lumen 23Fr Avalon Elite cannula which facilitated oxygen transfer rate of 100 mL/min at a flow of 2.5 L/min in a spontaneously breathing patient.[2]

Novalung (Hechingen, Germany) is an interventional lung assist membrane ventilator facilitating pumpless arteriovenous bypass approach for femoral cannulation in awake patients. It is designed for complete removal of CO_2 in hemodynamically stable patients.

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Clinical Indications of Awake ECMO

As a Bridge to Transplant

Veno-venous ECMO in awake, non-intubated spontaneously breathing patients might be preferable in patients awaiting lung transplant. These patients are the ideal candidates given their single organ dysfunction. It can lead to great benefit from preoperative physical rehabilitation and limiting the risk of more invasive mechanical ventilation. Several case series have been published over the past years showing the benefit of awake ECMO (Tables 1 and 2).

The strategy of awake ECMO has been tried even in veno arterial (VA) ECMO in concordance with the case report described by Dr Sanjay et al. and Mojoli et al. have described case series of 16 patients in whom VA ECMO was used in primary cardiogenic shock as a bridge to transplant or recovery, out of 16 patients, four were never intubated with good outcomes.[3–11]

In Severe Chronic Obstructive Pulmonary Disease Exacerbations

Severe chronic obstructive pulmonary disease (COPD) exacerbations warranting invasive mechanical ventilation have worse prognosis. Since COPD patients are usually characterized by hypercapnia and mild hypoxia, low blood flow extracorporeal CO_2 ($ECCO_2$) removal might be of great advantage in avoiding the potential adverse effects of mechanical ventilation. Studies have shown a reduced

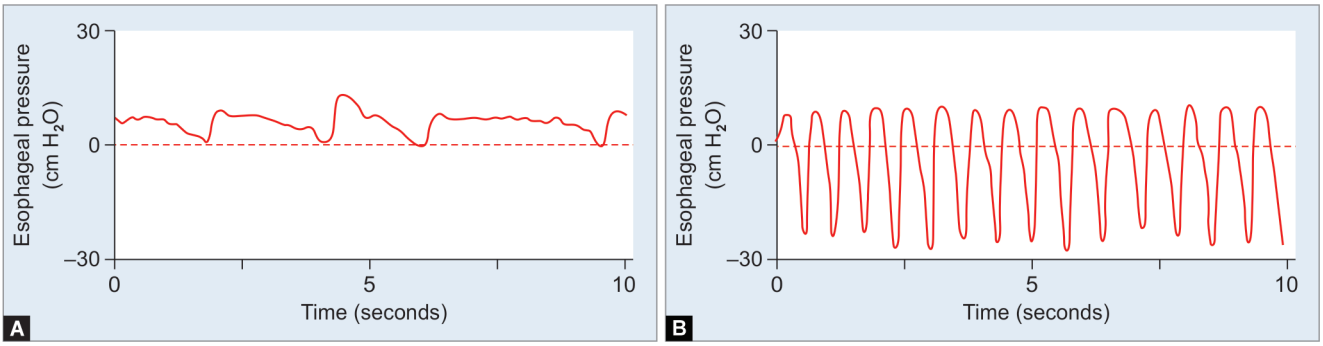

Fig. 1: In subparts: (A) Esophageal pressure swings during spontaneous breathing in healthy lungs with pressure fluctuations between 4 and 6 cm H_2O; (B) In acute respiratory distress syndrome patient there is a wide fluctuating esophageal pressure in the range of 20–30 cm H_2O[1]

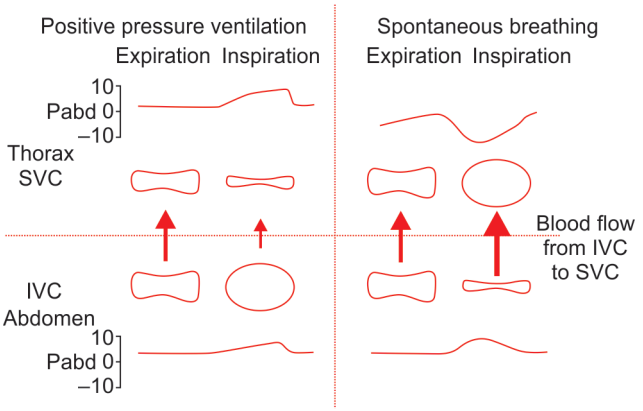

Fig. 2: Effect of spontaneous breathing and positive pressure ventilation on large veins.[1] This is an important phenomenon to acknowledge as it can have a bearing on ECMO cannulation choices in spontaneously breathing subjects

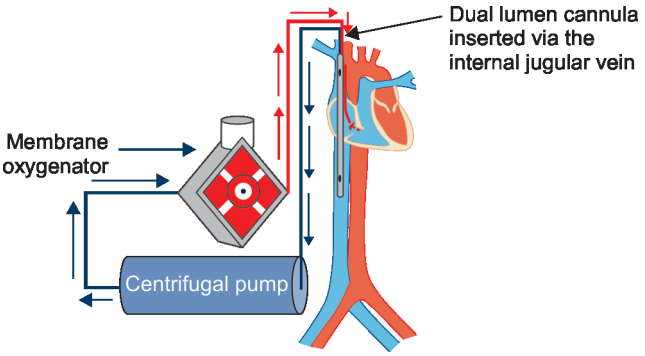

Fig. 3: Veno-venous ECMO

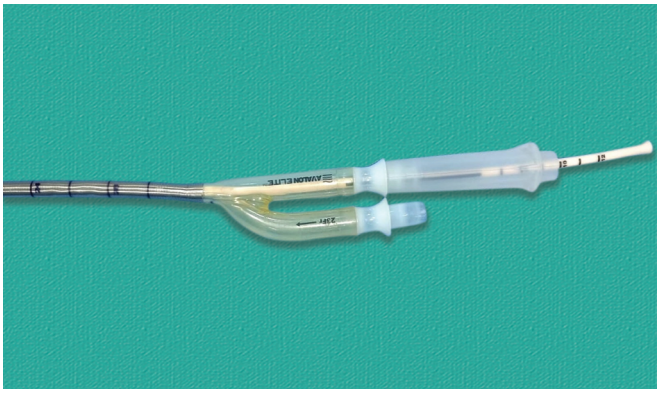

Fig. 4: Avalon 23FR double lumen cannula

Fig. 5: Novalung for extracorporeal carbon dioxide removal

intubation rate failing noninvasive ventilation and supported with extracorporeal gas exchange.

In Acute Respiratory Distress Syndrome Patients

In a case series published by Hoeper et al., awake ECMO was initiated in 16 acute respiratory distress syndrome (ARDS) patients without initiating mechanical ventilation. Noninvasive ventilation was stopped within 1 hour of initiating ECMO in two patients and in three patients ECMO was gradually weaned off. The rest of the patients were intubated for non-ARDS reasons, i.e., iatrogenic pneumothorax, bleeding, and delirium. Out of 16 patients, 15 survived.[12]

During COVID-19 pandemic, there was a higher incidence of pneumothorax and pneumomediastinum.[13] As reported by various researchers, the strategy of awake ECMO had encouraging results.[14,15] Awake ECMO although has several theoretical advantages, the evidence is equivocal. In a case series described by Mang et al., 18 patients with COVID-19 related severe ARDS patients awake ECMO was initiated. Out of 18 patients, 14 patients (78%) were intubated during intensive care therapy. Main reason for switching over to invasive mechanical ventilation was delirium, patient's explicit wish to be sedated, tension pneumothorax, major bleeding, and failure to oxygenate despite high ECMO flows. Awake ECMO patients requiring delayed intubation had worse survival rates compared to overall cohort (9/14, 64 vs 50% in the overall cohort). Main findings of this study were:

Table 1: Veno-venous ECMO

Reference	*Year*	*Number of patients*	*Average bridge days*	*Type of extracorporeal support*	*Successful bridge*
Olsson et al.[3]	2010	5	21	VA	4/5
Hoopes et al.[4]	2013	18	11	VV (10), VA (2), PA-LA (2), RA-Ao (4)	18/18
Crotti et al.[5]	2013	18	11	VV (8), VA (1), AV (1)	8/10
Lang et al.[6]	2014	5	21	AV (2), VV (2)	5/5
Inci et al.[7]	2015	6	NA	NA	6/6

AV, atrioventricular; NA, not available; PA-LA, pulmonary artery-left atrium; RA-Ao, right atrium-aorta; VV, veno-venous

Table 2: COPD patients with extracorporeal gas exchange

Reference	*Year*	*Type of disease*	*Number of patients*	*Average support duration (days)*	*Type of extracorporeal support*	*Successful management without IMV*	*Successful weaning from IMV*
Burki et al.[9]	2013	COPD	20	4	Low flow $ECCO_2R$	9/9	3/11
Abrams et al.[10]	2013	COPD	5	8	Low flow $ECCO_2R$	NA	5
Del Sorbo et al.[11]	2015	COPD	25	2	Low flow $ECCO_2R$	22/25	NA

- A high rate of awake ECMO patients were intubated.
- Those subsequently intubated seem to have higher mortality than patients managed with conventional invasive mechanical ventilation and ECMO.[16]

Patient selection is the key to success and might be more effective if considered early during the course of illness potentially avoiding cumulative effect of ventilator induced lung injury (VILI) and secondary infections.

The main contraindications for awake ECMO are uncontrolled sepsis with multiorgan failure, poor quality of life, severe bleeding disorders, and advanced malignancies.

Awake ECMO emphasizes the concept of "less is better" with a strong physiological basis and current scientific innovative equipment facilitating safer application seems to give a promising future but its real-life applicability on large cohort of patients remains unexplored warranting larger randomized controlled trials.

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