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CASE SERIES

Combined endoscopical treatments for tracheo-esophageal fistula developed during V-V ECMO for severe COVID-19: A case series

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1 | INTRODUCTION

Patients affected with acute respiratory distress syndrome due to Covid-19 may require veno-venous extracorporeal membrane oxygenation (V-V ECMO), often undergoing tracheostomy.[1,2] Tracheo-esophageal fistula (TEF) can develop as an immediate or late complication of tracheostomy, and can be enhanced by several conditions co-existing in severe Covid-19, such as malnutrition, soft tissue hypo-perfusion, need for high-dose vasopressors, mechanical damage during prone position, long hospitalization and ventilation, and long presence of nasogastric tubes.[3]

Furthermore, TEF can be dramatic in these patients since it may potentially progress to a mediastinitis, worsening the outcomes. The "watch and see" approach takes too long to allow tissue recovery, and it is also in contrast with the need for anticoagulation,[4] as well as infection control and adequate nutrition, so it would extremely delay the patient's recovery. At the same time, during ECMO, the surgical approach may also be dangerous in terms of bleeding complications and risk of infection. A pro-active approach with advanced endoscopic may contribute to reduce the overall mortality and improve the success rate.[5]

ECMO has been used for respiratory support after esophageal or tracheal surgery to allow apneic procedures or for the healing of TEF, especially in coronavirus (COVID-19) patients. On the opposite, ECMO is a potential tool to support endoscopy or other surgical procedures in severely ill patients with very low respiratory reserve, in fact, ECMO might guarantee adequate oxygenation while the ventilation is stopped to proceed.

TABLE 1 Summary of the characteristics of the patients

Characteristics of the patients ($n = 4$)	
Gender (M/F)	3/1
Age, years (mean ± SD)	74.5 ± 9
BMI, Kg/m^2 (mean ± SD)	25.95 ± 3.165
Total stay at ICU, days (mean ± SD)	115 ± 53,70
Time on ECMO, days (mean ± SD)	68.75 ± 36.59
Deaths	2 (50%)[a]

Abbreviations: BMI, body mass index; DS, deviation standard; ECMO, extracorporeal membrane oxygenation; ICU, intensive care unit.

[a]One patient recovered and was discharged, while another patient is still in the ICU.

TABLE 2 Individual data of the patients, including ECMO parameters and ICU stay

	Patient 1	Patient 2	Patient 3	Patient 4
Gender	M	M	M	F
Age, years	61	65	58	55
BMI, Kg/m^2	29.4	24.5	22.3	27.6
Pre-ECMO parameters				
Hospital stay pre-ECMO (days)	17	7	17	15
PaO_2 FiO_2/$PaCO_2$ (mm Hg)	63/104	66/45	66.6/52.2	39/102
pH	7.2	7.45	7.4	7.41
FiO_2 (mm Hg)	100	85	100	100
PEEP (cmH_2O)	14	6	6	8
Tidal volume/predicted body weight	5	6	6	2
Respiratory rate (BPM)	–	32	28	35
Plateau (cmH_2O)	27	24	39	33
Mean airway pressure (cmH_2O)	24	23	33	27
Lung injury score (Murray score)	3.3	3.3	3.8	3.5
Lung recruit maneuver	Yes	Yes	Yes	Yes
Pronation	No	Yes	Yes	Yes
Number of quadrants at chest X-ray	4	4	4	4
SOFA score	6	5	5	8
APACHE II score	11	15	15	15
SAPS 2 score	25	43	36	29
Length of stay from intubation/tracheostomy to diagnosis of tracheo-esophageal fistula (days)				
Airways device	Tracheostomy	Tracheostomy	Tracheostomy	Orotracheal intubation
Intubation days pre-TEF diagnosis	28	58	56	25
LOS tracheo to fistula	9	52	39	NA
Complications on ECMO				
Hemorrhagic complication airways	No	No	No	No
ECMO circuit complication	No	Yes	Yes	Yes
Circuit complication membrane clotting	No	Yes	Yes	Yes
Circuit complication cannula thrombosis	No	No	No	No
ECMO outcomes				
Length of stay on ECMO (days)	33	115	80	47
Hospital discharge alive	Yes	No	No	–

Abbreviations: APACHE, acute physiology and chronic health evaluation; BMI, body mass index; BPM, breaths per minute; ECMO, extracorporeal membrane oxygenation; LOS, length of stay; PEEP, positive end-expiratory pressure; SAPS, simplified acute physiology score; SOFA, sequential organ failure assessment.

2 | CASE SERIES

We experienced four cases of TEF among our first 36 tracheostomized patients on V-V ECMO during the COVID-19 second wave, between October, 2020 and May, 2021 (Table 1). Our cases had a mean length of stay (LOS) from intubation to the diagnosis of TEF of 41.75 days, while the mean LOS from tracheostomy to the diagnosis of TEF was 33.3 days. Table 2 shows the individual data of the patients. In all cases, the tracheostomy was performed by an experienced intensivist, while the patient was under apnea and full ECMO support to reduce the droplet spreading. The tracheostomy was performed via the percutaneous Ciaglia Blue Rhino technique (Ciaglia Blue Rhino, Cook Critical Care, Bloomington, Illinois).[6]

Our approach to TEF consisted of one-time esophageal endoluminal suture, tracheostomic cannula replacement downstream, and percutaneous endoscopic gastrojejunostomy (PEG-J). Procedures were performed at the bedside. Our clinical practice consists of interventional procedures and patient management in line with the guarantee to propose the best therapeutic option. The informed consent

before every procedure acts as a guarantee for it, and it was obtained from a guardian ad litem if assigned, otherwise, the attending physician acted as a guarantor.

First, under direct endoscopic guidance, the tracheostomic cannula was replaced with an adjustable flange longer cannula, which was relocated downstream (the distal tip placed about 2 cm from the tracheal carina) to overcome the injured tracheal wall. We then inserted the gastrostomy tube (Cook) using the "pull" technique and advanced the coaxial jejunal tube through the wire blocked by a foreign-body forceps over the Treitz ligament. So, we guaranteed both enteral nutrition and gastric aspiration, with a reduction in chemical stress at the fistula site. Finally, the TEF was closed with 1 or 2 discontinued sutures using the endoluminal endoscopic suture system (E-Video). Our management allowed us to treat all four TEFs, with a technical success rate of 100%, and recurrence at 4 weeks of 25%.

3 | CONCLUSIONS

In our COVID-19 series, despite tracheostomy was performed by experienced personnel and despite there were no immediate complications we experienced a higher rate of TEF. The cause of the TEF is multifactorial and it is not known if COVID-19 patients are at higher risk to develop it. Some of them might be by the reduced availability of devices to reduce the mechanical stress on the trachea maintaining the tubes, the frequent and long-prone position after tracheostomy with further stress of the posterior tracheal wall, and also some patients' characteristics like the need for vasopressor and, potentially, the gastrointestinal sufferance due to COVID-19. Moreover, complications in ECMO may worsen the outcomes of already fragile patients, and a surgical approach to TEF may prolong the ICU-stay and, even lead to death. A less invasive treatment seems to be feasible and might improve the survival of these patients in the coming years. In conclusion, preliminary data suggest endoluminal sutures as a feasible treatment for TEF developed during V-V ECMO and the extracorporeal support might allow a safe a smooth procedure since it allows complete gas exchanges support during the procedure also during apnea times.

CONFLICT OF INTEREST

None.

AUTHOR CONTRIBUTIONS

Dr. Antonino Granata: conceptualization, methodology, resources and comments; Dr. Gennaro Martucci: resources, comments and data analysis; Dr. Giacomo Emanuele Maria Rizzo: manuscript writing, design, methodology, video editing, and image providing; Dr. Mario Traina: supervision, comments, and data analysis; Prof. Antonio Arcadipane: supervision, comments and data analysis; All the authors revised the manuscript and agreed on its conclusions.

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REFERENCES

1. Barbaro RP, MacLaren G, Boonstra PS, Iwashyna TJ, Slutsky AS, Fan E, et al. Extracorporeal membrane oxygenation support in COVID-19: an international cohort study of the Extracorporeal Life Support Organization registry. Lancet. 2020;396(10257):1071–8. https://doi.org/10.1016/S0140-6736(20)32008-0
2. Lorusso R, Combes A, Coco VL, De Piero ME, Belohlavek J, Delnoij T, et al. ECMO for COVID-19 patients in Europe and Israel. Intensive Care Med. 2021;47(3):344–8. https://doi.org/10.1007/s00134-020-06272-3
3. Lorusso R, Cho SM, Canner J, Caturegli G, Choi CW, Etchill E, et al. Risk factors of ischemic and hemorrhagic strokes during venovenous extracorporeal membrane oxygenation: analysis of data from the Extracorporeal Life Support Organization registry. Artif Organs. 2021;49:91–101.
4. Mazzeffi M, Kiefer J, Greenwood J, Tanaka K, Menaker J, Kon Z, et al. Epidemiology of gastrointestinal bleeding in adult patients on extracorporeal life support. Intensive Care Med. 2015;41:2015.
5. Ichinomiya T, Murata H, Sekino M, Yokoyama H, Ogami-Takamura K, Higashijima U, et al. Tracheobronchial stent insertion under veno-venous extracorporeal membrane oxygenation in a coronavirus disease 2019 patient. J Cardiothorac Vasc Anesth. 2021. https://doi.org/10.1053/j.jvca.2021.09.009
6. Rossetti M, Vitiello C, Campitelli V, Cuffaro R, Bianco C, Martucci G, et al. Apneic tracheostomy in COVID-19 patients on veno-venous extracorporeal membrane oxygenation. Membranes. 2021;11(7):502. https://doi.org/10.3390/membranes11070502

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