BRIEF RESEARCH COMMUNICATION

Transesophageal Echocardiographic Assessment in Patients with Severe Respiratory Distress due to COVID-19 in the Prone Position: A Feasibility Study

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Abstract

Background and aim: Our aim was to assess the feasibility, safety, and utility of implementing transesophageal echocardiographic screening in patients with coronavirus disease-2019 (COVID-19)-related acute respiratory distress syndrome (ARDS), receiving mechanical ventilation (MV) and in prone position (PP).

Methods: Prospective observational study performed in an intensive care unit; patients 18 years, with ARDS, invasive MV, in PP were included. A total of 87 patients were included.

Results: There was no need to change ventilator settings, hemodynamic support, or any difficulties with the insertion of the ultrasonographic probe. Mean duration of transesophageal echocardiography (TEE) was 20 minutes. No displacement of the orotracheal tube, vomiting, or gastrointestinal bleeding was observed. Frequent complication was displacement of the nasogastric tube in 41 (47%) patients. Severe right ventricular (RV) dysfunction was detected in 21 (24%) patients and acute cor pulmonale was diagnosed in 36 (41%) patients.

Conclusion: Our results show the importance of assessing RV function during the course of severe respiratory distress and the value of TEE for hemodynamic assessment in PP.

Keywords: Acute respiratory distress syndrome, Coronavirus disease-2019, Prone position, Transesophageal echocardiographic screening.

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Highlights

This study assessed feasibility of transesophageal echocardiographic screening in patients with COVID-19-related ARDS, MV, and in PP.

With a sample of 87 patients, our results show the utility of transesophageal echocardiographic for hemodynamic assessment in patients in this context.

Introduction

During the COVID-19 pandemic, many patients with ARDS presented with a severe and prolonged impairment of gas exchange, which required invasive mechanical ventilation (IMV).[1] This support was implemented according to a lung protective protocol that included the titration of positive end-expiratory pressure (PEEP).[1,2] Moreover, patients with ARDS often present with RV dysfunction and multifactorial hemodynamic alterations, which make the management of these patients especially challenging.[3–5] Transesophageal echocardiography is the gold standard imaging tool to evaluate hemodynamic alterations in ventilated patients[6] and acute cor pulmonale,[3] and we hypothesized that it could be useful in this scenario.

In our unit, all COVID-19 ventilated patients with ARDS were evaluated with TEE in accordance with a specific protocol. Although the literature shows that PP in the setting of ARDS has benefits if implemented for at least 18 hours per day,[7,8] because of the number of patients who were being simultaneously ventilated and the many difficulties accomplishing this goal, PP was maintained for longer periods, from 48 to 72 hours. In this group of patients who were under deep sedation, receiving neuromuscular blocking agents (NBAs) and requiring vasopressor drugs, hemodynamic evaluation by TEE became crucial, a challenging situation for intensivists. Our aim was to assess the feasibility, safety and utility of implementing TEE screening in patients with COVID-19-related ARDS.

Methods

This was a prospective observational study performed between June 2020 and September 2021. We included patients over 18 years of age admitted to the intensive care unit (ICU) of the Hospital

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Alemán de Buenos Aires, with IMV, in PP, and with severe ARDS, according to the Berlin definition,[9] with a *P/F* ratio (PaO_2/FiO_2) of <150 despite PEEP optimization until obtaining a plateau pressure of <28 cm H_2O and a driving pressure of <18 cm H_2O. We excluded three patients with contraindications for TEE, while in PP[10] one patient was anticoagulated and two patients had a recent history of gastro-oesophageal surgery.

Transesophageal echocardiography was performed with a Philips CX50 (Koninklijke Philips N.V., The Netherlands) multiplanar TEE probe with a 5 MHz transducer by two operators certified in critical care echocardiography. Before insertion of the probe, enteral nutrition was interrupted, and stomach contents were emptied by suctioning through the nasogastric tube. All patients were under sedation with a Richmond Agitation-Sedation Scale of −4. The images were classified according to their quality into one of the following categories: grade I (poor image quality), grade II (satisfactory), and grade III (excellent image quality). Feasibility was evaluated according to the difficulty of introducing the TEE probe and the time, in seconds, required to obtain ultrasound images in the deep transgastric view. We evaluated the hemodynamic tolerance of patients during the study. Patient safety was assessed according to the need to increase vasopressor drugs, fluid bolus requirements due to a drop in blood pressure, and the need to increase fraction of inspired oxygen (FiO_2). The usefulness of TEE was explored in terms of whether it generated changes in ventilator settings or hemodynamic support.

Categorical variables were summarized as absolute numbers and percentages. Numerical variables were summarized as mean and range. Given the descriptive nature of the study, no statistical comparisons were made, and no hypothesis testing was made. All the descriptions were performed using R software version 4.1.1. The study was approved by the independent ethics committee of the Hospital Aleman de Buenos Aires, and informed consent was obtained from the patients included in the study or their families.

Results

During the study period, 355 patients with a confirmed diagnosis of COVID-19 by real-time reverse transcription polymerase chain reaction (RT-PCR) were admitted. Of these, 202 (57%) required IMV. Out of these patients, 92 (46%) were placed in the PP at least once during mechanical ventilatory support. Five patients were excluded; four patients did not have a TEE because they did not show hemodynamic instability during MV, whereas the fifth patient was excluded because of a poor acoustic window, and this was an obstacle to the correct assessment of ventricular function. A total of 87 patients were finally included in the study after TEE evaluation during PP.

No changes in patient vital signs (heart rate, respiratory rate, blood pressure, or oxygen saturation) were observed during the study. There was no need to change the ventilator settings or hemodynamic support. There were no difficulties with the insertion of the ultrasonographic probe in any of the patients. It was not necessary to use laryngoscopy or any other device for its insertion. The mean placement time was 20 seconds (range: 10–25 seconds) to obtain an image of the cardiac cavities in the deep transgastric view.

The mean duration of TEE was 20 minutes (range: 15–35 minutes), and all patients were on continuous intravenous infusion of NBA at the time of the study. No displacement of the orotracheal tube, vomiting, or gastrointestinal bleeding were observed. The complications observed were displacement of the nasogastric tube in 41 (47%) patients and superficial injuries in the oral mucosa in 2 (2.3%) patients with minor bleeding during the tube insertion (Table 1). Regarding biosafety complications in the context of COVID-19, in 10 (11%) patients there was accidental disconnection of the ventilator tubing, which led to aerosolization from the MV circuit. Although participating staff were not screened for COVID-19, no operator presented with symptoms or diagnoses compatible with COVID-19 during the study.

Table 1: Complications during TEE

Complications	*All TEE in PP (n = 87)*
Mouth/dental injury, *n* (%)	2 (2)
Nasogastric tube dislodgement, *n* (%)	41 (47)
Accidental depressurization of MV circuit, *n* (%)	10 (11)
Breach of operator's personal protection barriers, *n* (%)	0 (0)
Hemodynamic instability with study suspension, *n* (%)	0 (0)
Accidental extubation, *n* (%)	0 (0)

Table 2: Ultrasound findings

Ultrasound findings	*All TEE in PP (n = 87)*
Measurements, mean ± SD	
Heart rate, mean ± SD	84.8 ± 24.0
Cardiac output (L/min), mean ± SD	6.3 ± 2.0
LVOT VTI, mean ± SD	19.4 ± 5.0
EF Simpson (%), mean ± SD	56.7 ± 9.0
E/A, mean ± SD	1.17 ± 0.5
TAPSE (mm), mean ± SD	16.7 ± 4.0
FAC-RV (%), mean ± SD	34.2 ± 12.0
SVC variability (%), mean ± SD	9.17 ± 13.0
Number of patients with altered findings, *n* (%)	
Severe LV systolic dysfunction (<30%), *n* (%)	1 (1)
Severe RV severe dysfunction (FAC-RV ≤30%), *n* (%)	21 (24)
Cor pulmonale, *n* (%)	36 (41)

LVOT, left ventricular outflow tract; SD, standard deviation; SVC, superior vena cava; VTI, velocity time integral

The main echocardiographic findings are summarized in Table 2. Severe left ventricle (LV) systolic dysfunction, with an ejection fraction (EF) <30% measured by the modified Simpson's biplane method, was detected in 1 (1%) patient. In contrast, severe RV dysfunction measured as a fractional change in RV area ≤35% was detected in 21 (24%) patients. Acute cor pulmonale was diagnosed in 36 (41%) patients.

Limitations

Our study was observational and performed in a single center; nevertheless, the number of patients evaluated and our results show the importance of assessing RV function during the course of severe respiratory distress and the value of TEE for hemodynamic assessment in critically ill patients in PP. Other limitations were contrast echography and 3D technology were not available in our setting, and saline contrast had to be used for the diagnosis of foramen ovale (with no positive findings in the studied population). We used fractional area change (FAC) for RV function assessment

and measured tricuspid annular plane systolic excursion (TAPSE) in the deep transgastric view, which added to the FAC value to complete RV function assessment.

Conclusion

The COVID-19 pandemic has placed ICUs worldwide under enormous challenges. The need for IMV and PP makes it difficult to perform transthoracic echocardiographic evaluations, especially for RV function, which is critical in the setting of severe ARDS. Here, we showed the safety and usefulness of TEE for hemodynamic evaluation in patients in PP. Our study highlights the predominance of RV dysfunction over LV dysfunction and the high percentage of acute cor pulmonale. This hemodynamic information obtained by TEE enabled us to start therapies to support RV function as well as optimize ventilation settings and, therefore, reduce PEEP.

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