

THE FIRST HYBRID SURGERY IN CHINA: REPAIR OF TRACHEAL LACERATION WITH EXTRACORPOREAL MEMBRANE OXYGENATION

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ABSTRACT

Objective: In this example, the patient accidentally fell from 8 meters high, causing trauma to the patient's chest with tracheal laceration and 'white lung' in both lungs. The patient lost respiratory function and was using a breathing machine with 100% pure oxygen while still maintaining 80% oxygen saturation. Routine tracheal intubation under general anaesthesia could potentially cause patient death during the operation. The objective was to assess the use of extracorporeal membrane oxygenation (ECMO) in surgery to repair the patient's tracheal laceration.

Methods: The thoracic surgery department applied hybrid surgery combined with ECMO to rescue the patient. With the support of ECMO, the patient's intraoperative vital signs were stable, blood oxygen saturation was 100% and the surgery for repairing the laceration with fiberoptic bronchoscopy was successfully completed.

Results: The patient recovered and was discharged from hospital.

Conclusion: ECMO has successfully treated many critically ill COVID-19 patients during the pandemic, but this is the first time in China that ECMO has been applied to patients suffering from multiple critical injuries such as chest trauma and tracheal laceration.

Keywords: Chest trauma, tracheal laceration, extracorporeal membrane oxygenation.

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Introduction

Many doctors refer to extracorporeal membrane oxygenation (ECMO) as an 'artificial heart-lung machine', and it is used as the last means of treatment for patients with cardiopulmonary failure^(1, 2). ECMO is described by clinicians as the 'last magic weapon' for the treatment of critically ill patients. While many critically ill COVID-19 patients have been successfully treated during the pandemic with ECMO, this is the first time that the process has been applied to patients with multiple critical injuries –

chest trauma and tracheal laceration – in China. In this paper, a patient with thoracic trauma and tracheal laceration was treated by a hybrid surgery of ECMO-supported thoracotomy repair. The report is as follows.

Clinical data

The patient, 45 years old, was working when they accidentally fell from a height of 8 meters, and immediately entered a coma. After two days in the local hospital, he was transferred to our hospital

and put on an endotracheal intubation ventilator. On admission, CT scan and other examinations were performed to diagnose the patient. Multiple critical injuries were found, including severe shock, respiratory failure, hepatic contusion, brain contusion, severe chest trauma (bilateral multiple fractured ribs, haemopneumothorax, severe pulmonary contusion, myocardial contusions and two instances of haemopericardium). The patient received tracheal intubation with 100% pure oxygen respirator-assisted ventilation, with oxygen saturation around 80% and a heart rate of about 120 beats/min. Fiberoptic bronchoscope examination revealed that the main part of the trachea was damaged about 1 cm above the carina and the size of the tear was about 1 cm.

To perform surgery on this severe chest trauma combined with tracheal laceration, the thoracic surgery team worked closely with the ECMO team, anaesthesia team, operating room team, bronchoscopy team and cardiac surgery team to perform an emergency hybrid surgery of thoracotomy repair for tracheal laceration supported by ECMO.

Intraoperative findings and procedure

After endotracheal intubation and the anaesthesia took effect, ECMO support was given via the leading right femoral vein and right internal jugular vein, which is known as veno-venous ECMO (VV-ECMO). After regular disinfection, four posterolateral incisions about 15 cm long were cut in layers between the right ribs to probe into the chest. 1 cm on the carina there were longitudinal cracks, approximately 1 cm long, slightly irregular and with local fibrin (Figure 1).

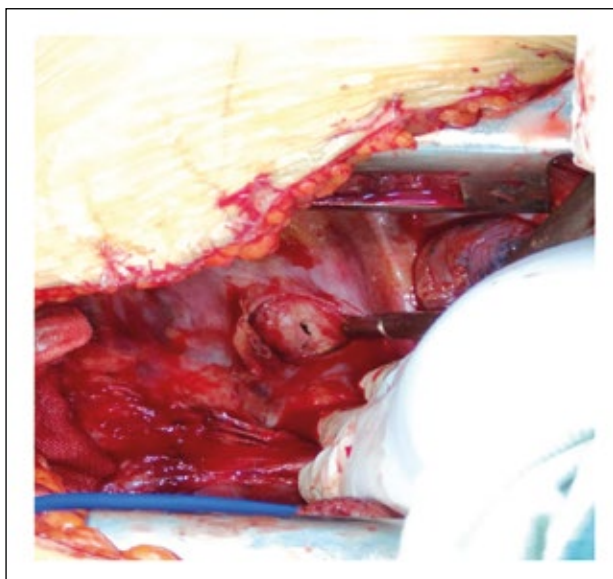


Figure 1: The trachea is lacerated at the arrow.

At the appropriate edge after finishing the incisions, fresh blood supply was evident. Full-thickness sutures were used to repair the tracheal rupture and pleura covers were sutured to the gap above. At the pericardium, after a pericardial window was created, blood was not coagulating and was flowing out. After repeated washing, cardiac power was measured repeatedly.

There was no obvious bleeding. The pericardial window was drained, and after the adding of water to the lung, the repair of the trachea without leakage could be seen. A thoracic drainage tube was placed in the sixth part of the midaxillary line and the chest was closed layer by layer. Intraoperative anaesthesia was satisfactory. The vital signs were stable 1 hour after the ECMO was stopped and the flow was observed. After the operation, patient was successfully taken off ventilation and the metal cannula and blocked tube were replaced and removed. A chest CT showed that double lung function was restored (Figure 2). The thoracic drainage tube was removed successfully and a fiberoptic bronchoscopy showed that the main tracheal laceration was repaired well without a bronchopleural fistula. Since then, the patient recovered and has been discharged.

It is reported that this was the first emergency ECMO support in China to rescue a patient with severe thoracic trauma and tracheal laceration.



Figure 2: Postoperative chest CT (2020-03-14).

The second discussion

ECMO is an advanced life support technology, sometimes referred to as a Yeke membrane. Performed on patients with intractable respiratory or heart failure, the principle of ECMO is to extract venous blood from the body and pump it back into the patient's blood circulation through artificial membrane oxygenation. The main support modes

are VV-ECMO and veno-arterial ECMO, which are simple and feasible treatment methods for acute and critical patients^(3,4). ECMO can be commenced if there are no contraindications and one of the following conditions is met: PaO₂/FiO₂ <80 mmHg and FiO₂ >90%; hypercapnia with PaCO₂ greater than 80 mmHg; platform pressure <30 cmH₂O; severe air leakage syndrome^(3,5). On the third day after the injury, the patient suffered haemorrhage after the tracheal laceration with a large amount of fluid leakage to the lungs, lung contusion and lung inflammation, effusion, unusually severe infection, and ‘white lung’ performance in both lungs (Figure 3).



Figure 3: Preoperative chest CT (2020-02-27).

The patient had basically lost respiratory function and was breathing 100% pure oxygen by machine, while still maintaining 80% oxygen saturation (Figure 4).



Figure 4: Preoperative ECG monitoring (oxygen saturation around 80%).

80% of the patient's breath leaked from the laceration and could not contribute to oxygen exchange. Within just 10 seconds of tracheoscopy, the patient's oxygen saturation dropped sharply to about

40% and the heart rate reached about 190 beats/min. There was the possibility of cardiac respiratory arrest and death at any time. The patient was in a critical condition and needed emergency surgical repair of the tracheal laceration, but the patient's lungs had not been affected by any wind and wind.

The patient was suffering from liver contusion, brain contusion, haemothorax, myocardial contusion, haemopericardium and other complex injuries. Routine tracheal intubation while under general anaesthesia can potentially cause patient death. The success rate for patients with this kind of traditional treatment is almost zero. The thoracic surgery team decided to immediately contact the ECMO team, cardiac surgery, anaesthesia team, operating room team and fibre bronchoscopy team. After a multidisciplinary collaborative discussion, it was agreed to use hybrid surgery combined with ECMO (not yet reported in China) to rescue the patient.



Figure 5: ECMO was carried out under the cooperation of extracorporeal life support centre, anaesthesiology department and thoracic surgery department.

With the support of ECMO, the patient's vital signs were stabilised during surgery and the thoracic surgical team repaired the tracheal laceration. Intraoperatively, both lungs were not ventilated, blood oxygen saturation was 100% (Figure 6), blood oxygen partial pressure was 98 mmHg and carbon dioxide partial pressure was 37 mmHg, which completely repaired the function of lungs. The surgery for laceration repair with fibroscopy was successfully completed. The patient gradually recovered function of both lungs and was successfully removed from ECMO. Throughout the COVID-19 pandemic, the main team of the thoracic surgery unit of Affiliated

Hospital of ZUN Medical University went to the frontline to fight against the pandemic, regardless of the threat to their lives. As part of the sixth medical team to aid Hubei province, they resolutely went to Jingchu. They achieved victory in the fight against the virus in Ezhou, keeping infections down to zero in the hospital and earning a triumphant return. Although the thoracic surgery was suffering a shortage of medical staff, the remaining medical staff tried to protect their patients, by fighting and not stopping or slacking in the unimaginable life and death struggle for patients to stay alive.

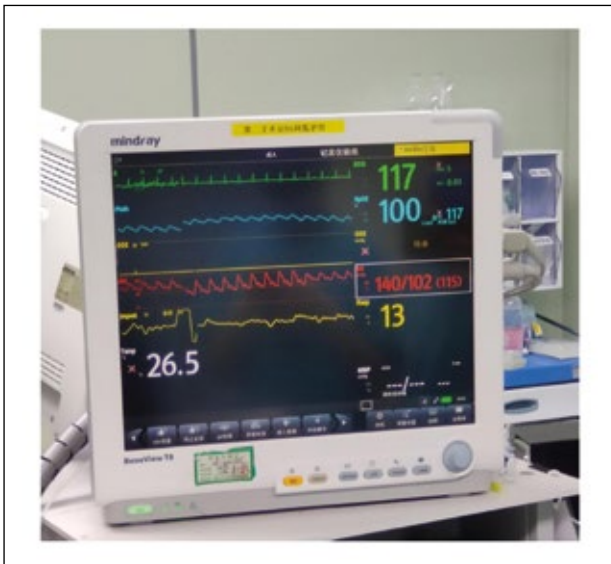


Figure 6: Electrical monitoring in the surgical centre after establishment of ECMO (oxygen saturation 100%).

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