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CASE REPORTS

Tracheostomy in a patient with severe acute respiratory syndrome

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The coronavirus which causes severe acute respiratory syndrome (SARS) is a virulent and highly contagious organism. Of the 1755 SARS patients in Hong Kong, over 400 were health-care workers. Meticulous attention to infection control and teamwork are essential to minimize cross-contamination and prevent staff from contracting the illness. These points are especially pertinent when anaesthetizing SARS patients for high-risk procedures such as tracheostomy. We describe the management of such a case.

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By the time Hong Kong was removed from the list of severe acute respiratory (SARS)-affected areas on June 23, 2003, there had been 1755 cases of SARS in Hong Kong. No new cases have been reported since then. A total of 299 patients died from the disease. Patients with the more severe form of SARS often required mechanical ventilation. For some of the patients who had a prolonged period of intubation, tracheostomy was needed for optimal respiratory care.

At our hospital, 184 patients were admitted with SARS between the end of March and early June 2003. Most of the patients were residents of Amoy Gardens where the largest community SARS outbreak occurred. Forty-two patients with SARS were admitted to our intensive care unit (ICU), 34 (81%) of whom required tracheal intubation and ventilatory support. Two patients had surgical tracheostomy. Twenty-seven of the 34 patients (79%) died despite drug therapy, mechanical ventilation and organ support. We report our experience of the anaesthetic management of a SARS patient undergoing surgical tracheostomy.

Case report

The patient was a 48-yr-old decorator who lived in Amoy Gardens. He was a hepatitis B carrier but was otherwise in good health. He went to the Accident and Emergency Department of our hospital on March 27, 2003 with fever and shortness of breath, and eventually SARS was confirmed. His condition deteriorated and he was admitted to the ICU on April 12 for mechanical ventilation. He was given ribavirin, kaletra (coformulation of lopinavir and ritonivir, both inhibitors of HIV protease), ritonivir, antibiotics, pulse methyprednisolone and immunoglobulin. His condition was further complicated by bilateral spontaneous pneumothoraces. His tracheal tube frequently became blocked with secretions. Thus, surgical tracheostomy was performed on May 7 when he was clinically more stable. Immediately before surgery he was on synchronized intermittent mandatory ventilation with pressure support mode. His arterial saturation was 92% when he was ventilated with oxygen 40%. Both chest drains were swinging but not bubbling. He was anaemic, with a haemoglobin concentration of 11 g dl^{-1} but his renal and liver function were normal. He was finally weaned off the ventilator 19 days after tracheostomy. He was transferred to a nearby district hospital for convalescence on June 5, a few days after being decannulated.

We operated on this patient with SARS in our newly constructed negative-pressure operating theatre. Before the operation, everyone concerned (patient, patient's relatives, intensivists, surgeons, anaesthetists and theatre staff) had a conference to discuss the indications for tracheostomy. The team consisted of the most experienced personnel in order to minimize operating time. All theatre personnel wore protective clothing consisting of a Tyvek® BarrierMan

(DuPont Nonwovens, Peoples' Republic of China) and water-resistant disposable gown, cap, boots, double gloves, goggles, N95 mask, and AirMate™ (3M Occupational Health and Environmental Safety Division, USA), with a Tyvek® head cover down to both shoulders. A practice run immediately before the operation was conducted to ensure smooth running of the whole procedure, including transfer to and from the operating theatre, surgery, and for decontamination and disinfection of the operating theatre. Particular attention was paid to the removal of staff's personal protective equipment to avoid self-contamination.

The patient's condition was optimized before transfer to the operating theatre. Midazolam 10 mg i.v. for sedation and rocuronium 40 mg i.v. for muscle relaxation were given before transfer and to reduce patient movement and coughing. Apart from essential monitors (ECG, arterial line and pulse oximetry), i.v. access, chest drains and other tubing and connections were reduced to a minimum to avoid the risk of disconnection and spillage of contaminated blood or other fluids. The patient was transported on an adjustable trolley with a portable ventilator to allow a safe distance between the patient and intensivist. After positioning with a shoulder support and head ring, the patient was operated on the trolley to reduce unnecessary disconnection of catheters and tubing during transfer to and from the operating table. Another surgeon, anaesthetist and team of theatre staff were on standby in the adjacent operating theatre to allow for rapid take over in case of problems.

Anaesthesia consisted of a titrated concentration of isoflurane (1–3%) in oxygen-enriched air ($F\mathrm{I}_{\mathrm{O}_2}$ 0.6) after doses of fentanyl (100 + 50 + 50 μg i.v.) and further doses of rocuronium (total 40 mg). After preoxygenation with oxygen 100% for 3 min, apnoea was allowed to facilitate incision of the trachea and insertion of a tracheostomy tube. When the surgeon signalled that he was going to incise the trachea, the cuff of the tracheal tube was deflated and the tube was pulled back 3 cm. No tracheal or wound suctioning was attempted, to avoid aerosol generation of blood or secretions. A closed suction system and a viral filter of 99.97% efficiency were incorporated into the catheter mount to facilitate suctioning in a closed system. Another viral filter was connected to the breathing circuit for added safety. Once the tracheostomy tube was in place, as confirmed by the presence of carbon dioxide on end-tidal gas sampling and chest movement, the tracheal tube was removed under a large piece of clear plastic in which it was immediately wrapped and disposed of in a plastic bag designated for contaminated waste. After the operation, which took 15 min, the patient was reconnected to the portable monitor and ventilator. Once his condition was stable, the patient was transferred back to the ICU by a separate transport team. This allowed the operating team ample time to decontaminate and disinfect the operating theatre, and then remove and dispose of their personal protective equipment without contaminating themselves.

Discussion

Coronavirus is the likely primary agent associated with SARS.[1] Normally, this viral agent causes a less severe form of illness with only mild respiratory symptoms. However, the altered form of the coronavirus that caused the 2003 SARS outbreak is virulent. In addition to the high mortality rate, which can be up to 17%, it is also highly contagious. More than 400 of the 1755 SARS patients in Hong Kong were healthcare workers. When anaesthetizing a patient with SARS for tracheostomy, apart from the clinical issues, we should pay meticulous attention to the details of infection control, in order to minimize cross-contamination and our own risk of contracting the illness.

The main treatment for SARS consists of antibacterial therapy, ribavirin and methylprednisolone. Non-invasive or mechanical ventilation should be considered if oxygen saturation is less than 98% on oxygen greater than 8 litre min^{-1}, or if the patient complains of increasing shortness of breath.[2] Some patients may benefit from tracheostomy after a few weeks of tracheal intubation.

Tracheal intubation and tracheostomy are aerosol-generating procedures which may facilitate transmission of the aetiological agent for SARS. It is thus recommended that aerosol-inducing procedures should be performed on SARS patients only when deemed absolutely necessary. Procedures should be carried out using both contact (e.g. gloves, gown and eyewear) and airborne precautions (e.g. respiratory protective devices with filter efficiency of greater than or equal to 95%).[3] One survey showed that the practice of droplet and contact precautions was adequate in significantly reducing the risk of infection after exposure to patients with SARS.[4] However, in Toronto three anaesthetists using traditional respiratory and contact precautions contracted SARS after intubating patients with respiratory failure of unknown cause.[5] In Hong Kong, three out of 160 ICU staff at one teaching hospital contracted SARS despite stringent measures being in place.[6] We therefore decided that, in addition to contact and airborne precautions, staff should use the 3M AirMate power air purifying respirator.[5] The AirMate and head cover are not easy to put on quickly and training is highly recommended. We also followed the recommendation of putting on a double gown for maximum protection.[5] The outer gown is water resistant and is removed in the operating theatre. The outer pair of gloves is changed to a clean pair just before leaving the operating theatre. The AirMate, BarrierMan and boots are removed in an adjacent gown-down area. We prefer the BarrierMan, which is a full body overall with hood, instead of an inner gown because it covers the neck and both lower legs. The BarrierMan is difficult to take off but training lessens cross-contamination. An inspector with full knowledge of infection control is required to supervise removal of personal protective equipment. Immediately afterwards, the staff should go directly to the changing room for a shower.

Smooth coordination is crucial to the whole procedure. The anaesthetist should coordinate the theatre staff and surgeons. After setting up the operating theatre, which ideally is negatively pressured, a short briefing session should be conducted to rehearse the transfer to theatre, the operation and transport of the patient from the operating room. As communication and the observation abilities of staff are hindered by the noisy, unfamiliar and isolated operating theatre environment and the bulky personal protective equipment, problems should be anticipated and managed according to an agreed plan. Basic equipment such as a stethoscope cannot be used. Audio alarm volumes must be turned up to allow detection of problems. Back-ups should be immediately available for optimal staff support.

In addition to the infection control measures, the anaesthetist faces other problems when caring for patients with SARS. Patients with SARS presenting for tracheostomy are in the pulmonary destruction phase of the illness. They often have a ground glass appearance on chest radiograph, poor arterial blood saturation, superimposed bacterial lung infection and a high risk of spontaneous pneumothoraces. The SARS process may affect the haematological system, resulting in anaemia, lymphopenia and thrombocytopenia. Patients may also have liver dysfunction reflected by raised alanine aminotransferase and hypoalbuminaemia.[1] Renal impairment may develop and patients may require renal replacement therapy. A clinical picture resembling disseminated intravascular coagulopathy may occur. All these problems may be further complicated by the drug therapy. Ribavirin can cause haemolytic anaemia, hypotension, brady/tachycardia, seizures, nephrolithiasis, elevated serum bilirubin and ammonia, and skin eruptions. Lopinavir has been associated with increases in serum cholesterol and triglycerides, and cases of pancreatitis have been reported.

We subsequently performed another surgical tracheostomy using a similar technique. To our knowledge, at least five SARS patients have had surgical tracheostomies at other hospitals in Hong Kong. Some hospitals did not have a negative-pressure operating theatre but the personal protective equipment they used was similar to ours. None of the hospital staff involved in the procedures contracted SARS. We are reassured by the favourable outcome.

As we recover from the impact of the SARS outbreak, it is obvious that we should critically examine infection control measures in daily practice, not only for the protection of patients but also for the protection of ourselves.

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