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CASE REPORT

Considerations on infectious complications using a drowned lung for transplantation

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Summary

Recently, the applicability of lungs from drowned victims for transplantation has been anecdotically described in literature. However, no data exist about hazards or limitations. Herein, we describe a case of lung transplantation from a submersion victim and the subsequent development of an *Aeromonas hydrophila* infection in the implanted organ. Based on this case we propose standard procedures, which should be followed when considering drowned donor lungs, in order to minimize risks for infectious complications.

Introduction

The number of patients considered for lung transplantation continues to increase. However, the application of transplantation in clinical medicine is still limited by the availability of suitable donor organs. This results in long waiting times for listed patients and a substantial risk of death before transplantation. Previously, attempts have been made to extend donor criteria in order to meet this growing demand.

Drowning is reported to be the third most common cause of all accidental deaths. Most of the victims are younger than 40 years of age [1]. Thus, considering the problem of donor shortage, the inevitable question arises if this large pool of organs could be utilized for lung transplantation. Conlan *et al.* have recently published first evidence on the applicability of donor lungs from a drowned victim [2]. Apart from this case report no data exist on the inclusion criteria, limitations or hazards of using donor lungs from drowning victims.

Aeromonas spp. are ubiquitous water-resident gram-negative micro-organisms infectious for fish, reptiles and amphibians. In humans, gastrointestinal and wound infections are associated with aeromonas after exposure to contaminated fresh and brackish water. Generally, the incidence of human infections with *Aeromonas* spp. is low, however, aeromonades have shown to be the major pathogens of pneumonia in near-drowning victims. Aeromonas pneumonia is a life-threatening situation with a lethality over 60% caused by the high occurrence of septic spreading. Therefore, an aggressive antibiotic regime is deemed pivotal in these patients [3]. Most *Aeromonas* spp. are susceptible to trimethoprim-sulfamethoxazole, aminogycosides, third generation cephalosporine, and fluoroquinolones [4].

Clinical summary

A 33-year-old nonsmoking female drowned in a river when trying to rescue a near-drowning child. She was immediately reanimated, haemodynamically stabilized and aspiration content was completely withdrawn by bronchoscopic suction. However, she had already developed severe hypoxic cerebral injury. After 24 h a

diagnosis of brain death from hypoxic brain injury was established. The patient was accepted as a lung donor after meeting all criteria for transplantation. Her chest radiography initially showed bilateral infiltrations consistent with aspiration of fresh water. However, infiltrations ameliorated and bronchoscopic findings were inconspicuously at the time of explantation. An oxygen challenge test on 100% oxygen revealed a PaO_2 of 442 mmHg. Since no data on infectious threats of drowned donor lungs are available, bronchoalveolar lavage (BAL) from both donor lungs was thoroughly performed before explantation.

A 41-year-old female suffering from chronic obstructive pulmonary disease (COPD; FEV_1 17.9%; FEV_1/VC 32.9%) listed for double-lung transplantation was chosen as recipient. The ischemic times of the donor lungs were 323 min for the right and 414 min for the left lung. Following the standard procedures in our institution aminopenicillin/β-lactamase inhibitor was used for perioperative antibiotic cover. Due to a severe reperfusion edema of the right lung, the implantation of a peripheral veno-arterial extracorporeal membrane oxygenation (ECMO) was decided intra-operatively. Fortunately, lung edema rapidly ameliorated and the ECMO could be explanted on postoperative day (POD) 2. Two days later the patient could be extubated. However, laboratory analysis revealed an inexplicable increase of C-reactive protein on POD 4 (max 24.35 mg/dl; cut-off: <1 mg/dl). Lung radiography showed diffuse infiltrates in both lungs (Fig. 1a). The same day, the microbiological results of the preoperatively taken BAL became positive for *Staphylococcus aureus* and *Aeromonas hydrophila*. Both pathogens showed high sensibility for trimethoprim–sulfamethoxazole. The antibiotic regime was changed immediately, infection parameters decreased and chest radiographies ameliorated thereafter (Fig. 1c). Subsequent microbiological evaluations of BAL were all negative, however, initially specimens contained high numbers of granulocytes. The patient could be discharged on POD 26. She did not experience any further infectious complications and on a routine visit 6 months later the patient is in good clinical condition.

Discussion

The applicability of lungs from submersion victims for transplantation has previously been addressed in a case report by Conlan *et al.* [2]. The authors state that lungs from dry-drowners can be considered as donors. In this minority of drowning victims severe laryngospasm develops and aspiration is prevented. Finally, cerebral asphyxia and hypoxic death occur. Our case extends these findings by reporting the first successful implantation of a submerged, flooded lung.

We decided to accept the lungs because of three reasons: (i) the donor submerged in fresh, noncontaminated water; (ii) the bronchoscopic findings were inconspicuous; and (iii) functional parameters were excellent.

Since microbial hazards in our case were completely unknown we performed serial BAL from both donor lungs in order to obtain a complete lower airway sampling. Thus, we were able to detect lower airway pathogen colonization at an early stage, enabling a fast and targeted antibiotic treatment.

At POD 4 our patient evidenced a significant rise in inflammatory parameters, which was subsequently explicable by the positive microbiological results for nonmethicillin resistant *Staphylococcus aureus* and *Aeromonas hydrophila* received on POD 5. Both pathogens are consistent with the donor organ's history.

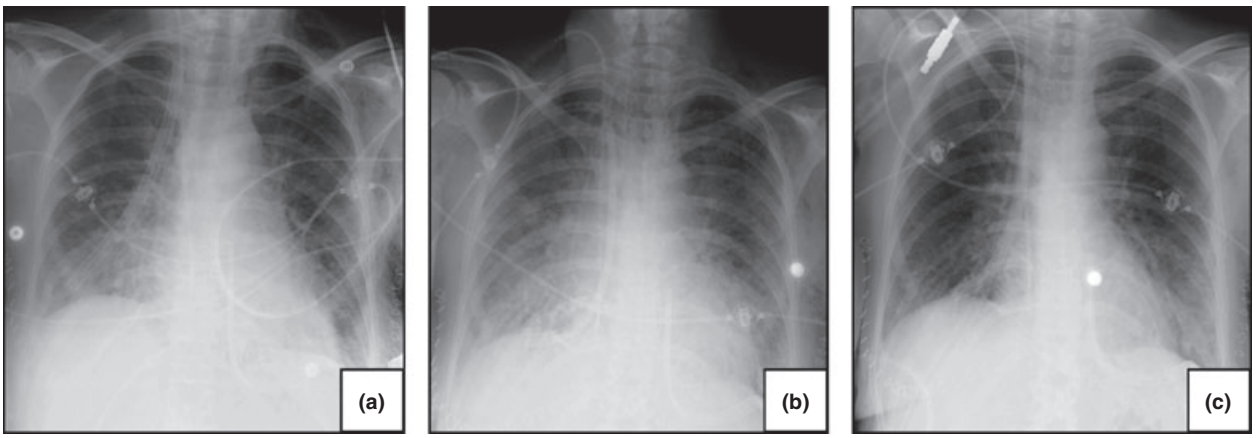

Figure 1 Radiographic images of the patient. (a) Diffuse infiltrates in both lungs can be seen on POD 5. (b) Despite adequate antibiotic treatment a spreading of the infiltrate was observed until POD 8, finally resulting in a nearly total resolution of lung infiltrates on POD 11 (c).

Pneumonia after near-drowning is almost exclusively caused by gram negative pathogens. *Aeromonas* spp., resident in both saltwater and freshwater, account for the majority of reported cases in literature [5]. Other gram-negative pathogens associated with pneumonia after near-drowning are *Burkholderia pseudomallei* and *Chromobacterium violaceum*. The latter are only endemic to Southeast Asia and subtropical climates. All water resident gram-negative bacteria were shown to be highly susceptible to trimethoprim–sulfamethoxazole, third generation cephalosporins and extended spectrum aminoglycosides [3].

Only few species of gram-positive bacteria can be cultured from sea- and freshwater. Despite this fact, staphylococcus and streptococcus pneumonia after submersion have been described in literature. Autoinfection into more distal airways during the aspiration event may explain these gram-positive bacterial infection.

Invasive infections with *Aeromonas hydrophila*, e.g. pneumonia are often associated with bacteraemia which is – especially in the setting of organ transplantation – considered a life-threatening event. Therefore, an aggressive and targeted antibiotic treatment is indispensable.

The number of patients in need of a lung transplant continues to rise faster than the number of available donors. Only a minority of cadaveric donors meet the present criteria for an ideal lung donor. However, there is evidence that the utilization of lungs considered as marginal can also be transplanted with good clinical results [6,7]. Therefore, most transplant units have relaxed their selection criteria. Sputum Gram stains and cultures are routinely obtained from all lung donors either by suction catheter or bronchoscopy. Ruiz *et al.* showed in a retrospective study that in 103 out of 197 (52%) donors lungs, infections could be detected at the time of explantation. However, due to antibiotic therapy transmission to the recipient occurs only 8% of all cases [8]. They conclude that the implantation of contaminated lungs cannot be avoided, but transmission can be minimized by an appropriated prophylactic antibiotic regimen.

In conclusion, our case report evidences that – in addition to dry-drowners – submerged lungs from drowning victims are feasible for transplantation. However, in order to minimize the risk of infectious complications we propose the following: first, thorough microbial lower airway sampling (BAL) should be performed before explantation in order to detect possible pathogens at the earliest. Consequently, a prophylactic antibiotic regime covering water-resident pathogens should be performed. Further experience will be needed to specify risks and outcomes of accepting organs from drowning victims for lung transplantation before they could be routinely applied.

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