Successful Pneumonectomy Following Cardiopulmonary Resuscitation in a Polytrauma Patient

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Abstract
We describe a female patient who sustained multiple trauma including severe blunt thoracic trauma with left pulmonary laceration. She survived the pneumonectomy necessary after cardiopulmonary resuscitation (CPR). Histology of the pneumonectomy specimen showed an incidental pT1 pN1 adenocarcinoma of the upper lobe.

Key Words
Polytrauma · Cardiopulmonary resuscitation · Pneumonectomy

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Introduction

Traumatic pulmonary laceration requiring pneumonectomy is associated with an extremely high mortality of 50–100% [1, 2]. If cardiopulmonary resuscitation (CPR) has to be performed in a multiple trauma patient with concomitant thoracic trauma, survival is unusual [3, 4]. We report a case believed to be the first instance of a multiple trauma victim surviving emergency pneumonectomy after CPR.

Case Study

A 39-year-old female was involved in a traffic accident in which her car overturned several times. Emergency medical services called to the accident scene noted decreased breath sounds on the left side of the chest, together with an ipsilateral flail chest and soft tissue emphysema. The patient also showed a right hemiparesis and focal neurology with differently sized pupils, both of which were reactive to light. She was intubated and ventilated with 100% oxygen. A chest drain was inserted into the second left intercostal space, and 1.5 l of colloid and 1 l of crystalloid solutions were given intravenously. During transfer, CPR had to be performed and another infusion of 0.5 l colloid and 1 l crystalloid administered due to nonrecordable blood pressure.

On arrival at the Department of Surgery, clinical examination showed a flail chest on the left, manifest as increased left thoracic surgical emphysema together with reduced breath sounds on the left. Large quantities of blood were aspirated through the laryngeal tube. Examination of the pupils confirmed a dilated left pupil, but both pupils reacted to light. The patient was hemodynamically stable, with a blood pressure of 150/100 mmHg and a pulse of 150 bpm.

Further clinical and radiologic evaluation revealed the following:

- a normal vertebral column, odontoid process and pelvis with no evidence of fractures;
- ultrasound of the abdomen showed no evidence of organ damage, no free fluid, and no signs of a pericardial effusion;
- extremities were clinically normal;
- catheter urine was clear, there was no hematuria;
- massive soft tissue surgical emphysema was clinically evident and confirmed by chest X-ray which also showed serial fractures of the third to eleventh left

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ribs, shadowing in the left hemithorax as well as a fractured left scapula and clavicle (Figure 1);
- bronchoscopy revealed bleeding from the left upper bronchus;
- a CT scan of the head was normal;
- Hb on admission was 7.3 g/dl, blood gases revealed a pH of 6.9, base excess was –18, pCO_2 amounted to 58 mmHg and pO_2 to 196 mmHg.

Simultaneous with diagnostic measures, a chest drain was inserted into the left fifth intercostal space, which drained 200 ml of blood. 15 min after arrival, the patient became hemodynamically unstable, her systolic blood pressure fell to 70 mmHg, and oxygen saturation dropped to 78%, while ventilation pressure increased, together with a diminution of breath sounds on the right. Suspecting a right-sided tension pneumothorax, a chest drain was inserted into the right fifth intercostal space, through which air escaped. Systolic blood pressure stabilized at 110 mmHg, and oxygen saturation increased to 92%. Cardioversion and i.v. xylocaine were given to stabilize a persistent tachyarrhythmia, but proved unsuccessful. Rapid volume substitution (1 l colloid, 1.5 l crystalloid, and 2 units of erythrocytes) and administration of bicarbonate resulted in an improved hemodynamic status, and 45 min after arrival the patient was taken to the operating room with suspected pulmonary laceration.

Surgical Approach

Following left anterolateral thoracotomy and opening of the pleura, a blood-filled left hemithorax was found. After aspiration of the blood with a cell saver, a severe drop in blood pressure was observed, followed by cardiac arrest. The left hilus was therefore clamped immediately and manual cardiac massage commenced. Following further rapid volume substitution (2 l in 10 min), buffering with 100 mmol of sodium bicarbonate and administration of 2 mg adrenaline, spontaneous cardiac activity returned after 30 s. Systolic blood pressure rose above 100 mmHg. Inspection of the left hemithorax revealed a shattered chest wall with muscle tears and a completely stove-in chest. Several rib fragments had perforated the pulmonary tissue and the lung hilus. In the lower segment, both pulmonary arteries and veins showed numerous tears, together with tears in the lower bronchus. The lower pulmonary vein was clamped and transected close to the heart. Its stump was oversewn in a continuous fashion with 4/0 prolene. Individual branches of the pulmonary artery were dissected and

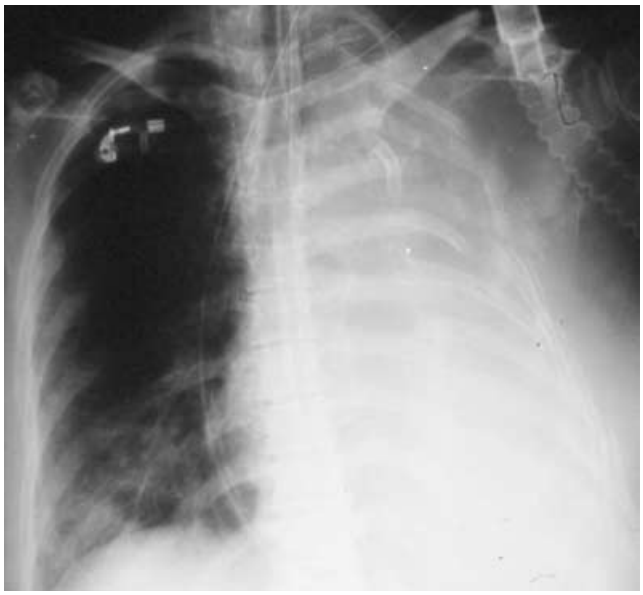

Figure 1. Chest X-ray.

transfixed separately. The torn lower lobe bronchus was divided using a TA 30 stapler. In the upper bronchus, there was massive hemorrhage from torn arterial branches supplying segments 1 and 2. The upper lobe bronchus and the pulmonary arteries showed massive contusion, and the upper lobe pulmonary tissue was destroyed to such an extent, that it had to be removed (Figure 2). Following transfixation of bleeding intercostal arteries, removal of sharp rib fragments and thoracic lavage, the pericardium, thoracic vertebral column and aorta were inspected and found to be intact. Subsequently, the left main bronchus was transected with a TA 55 stapler. The thoracic cavity was then filled with 0.9% NaCl, and no escape of air could be seen during

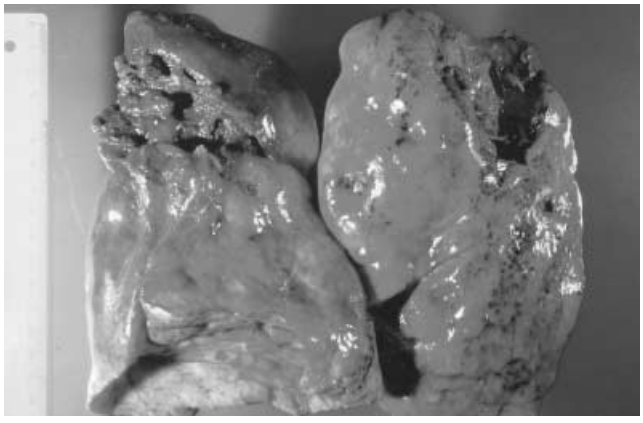

Figure 2. Destroyed upper and lower lobe pulmonary tissue.

positive pressure ventilation. After sealing of the bronchial stump using a fibrin tissue patch and pleura, a chest drain was inserted and the wound closed in layers.

Throughout the 3-h operation, the patient required a total fluid substitution of 11 l, including 2.5 l of retransfused cell saver blood, 8 units of blood, 800 ml of fresh frozen plasma, 1 l of human albumin, and 4 l of crystalloid. She was then transferred to the intensive care unit with an FIO_2 of 0.7, blood pressure of 110/60 mmHg, an Hb of 11.4 g/ dl, pH of 7.3, base excess of –7, pCO_2 of 34 mmHg, and pO_2 of 101 mmHg. Catecholamines were no longer necessary.

Outcome

Postoperative progress proved good, and catecholamines were not required. On the 1st postoperative day, the FIO_2 could be reduced to 0.3. Anastomoses were regularly checked by brochoscopy and found to be intact. The patient was extubated on the 6th day postoperatively. In spite of the administration of antibiotics, she developed an extreme right-sided pneumonia with *Klebsiella, Enterococci* and *Candida*, requiring reintubation and FIO_2 ventilation with up to 0.8. A tracheostomy was needed in order to wean her off the ventilator, which succeeded on the 32nd postoperative day. The initially diagnosed bilateral frontal brain contusion with pupil irregularity and hemiparesis regressed spontaneously and was no longer clinically evident; a CT scan of the head performed on the 36th postoperative day proved normal. On the 51st postoperative day, the patient was transferred to rehabilitation still showing signs of a mild psychoorganic brain syndrome. Her pulmonary function, however, was good. Surprisingly, histology revealed an incidental adenocarcinoma of the left upper lobe, which was staged as pT1 pN1 requiring further investigations.

Discussion

Severe thoracic trauma with concomitant pulmonary laceration is associated with a high mortality (50–100%) [1, 2], which is due to hypovolemia and pulmonary underperfusion resulting from massive blood loss. Furthermore, loss of gas exchange area and concomitant hypoxemia represent additional risk factors for the patient. Massive volume substitution and adequate ventilation in order to decrease pulmonary vascular resistance are amongst the decisive factors affecting the outcome. Any hypotension, which is a major factor in secondary hypoxic brain damage, has to be treated vigorously. Aggressive preclinical patient management with intubation, ventilation, rapid volume substitution, large-bore chest drain insertion (Charrière > 28) and, if necessary, defibrillation and CPR as well as rapid transfer to a thoracic surgery unit with facilities for immediate thoracotomy, can improve the patient's chances decisively [5, 6]. In cases of severe hemorrhage and/or unstable circulation, any time-consuming computerized chest tomography is to be avoided, as clinical evaluation, together with a chest X-ray, abdominal ultrasound and bronchoscopy, yields sufficient information about the patient's condition, the extent of the injury, and the need for surgical intervention [7]. In stable patients, bronchoscopy together with a plain chest X-ray is an important diagnostic tool in order to verify bronchial lesions. Computerized tomography exactly demonstrates any pulmonary, diaphragmal, cardiac and large vessel lesions and can be combined with a head scan at little time expense [8]. In hemodynamically stable patients, the discharge of more than 1 l of blood through the chest drain is an indication for emergency thoracotomy [9, 10]. After thoracic trauma, adequate hemorrhage control can often only be achieved by clamping the lung hilus. Early hilar clamping also increases the chances of survival [6, 11, 12]. In hypovolemic patients, it is seldom possible to achieve reestablishment of spontaneous circulation by drugs and external cardiac massage [4, 11, 13–15]. Open cardiac massage is much more effective in improving organ perfusion, which has also been shown experimentally [16] and is due to reduction of cardiac tamponade and prevention of further pulmonary tissue injury by bone fragments. In cases of trauma-associated pneumonectomy, the patient is compromised preoperatively by concomitant hypovolemia and hypoxemia, thus drastically reducing the chances of survival to 0–50% [1, 2, 8, 13, 18–20]. It has been demonstrated experimentally that elective pneumonectomy or hypovolemia alone both lead to increased pulmonary vascular resistance, which is in turn compensated for by an increased right ventricular pressure and enddiastolic volume as well as an increased heart rate, thus avoiding a fall in cardiac index output. The combination of hypovolemia and pneumonectomy, however, leads to an uncompensated increase in pulmonary vascular resistance with right cardiac failure, decrease of left ventricular preload, and a consecutive fall in cardiac index output [21]. Previous reports have suggested that the likelihood of survival decreases drastically in the presence of further concomitant organ system injuries [13, 18], especially concomitant blunt thoracic trauma rather

than penetrating thoracic trauma [6, 15, 17, 22–24]. Patients who underwent CPR prior to admission to hospital had minimal chances of survival [25, 26]. Survival of patients following CPR and thoracotomy was described as varying between 0–20% [4, 6, 27, 28]. Recommendations have been made to avoid emergency thoracotomy in patients with blunt thoracic trauma who underwent CPR [24, 29] or in patients sustaining concomitant injuries to other organ systems, but these should be viewed critically, as survivors have been described [30]. Our case demonstrates, that it is possible to survive a pneumonectomy following CPR in blunt thoracic trauma. The histologic finding of an incidental pT1 pulmonary adenocarcinoma in the resected left upper lobe remains a curiosity.

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