Outcome in patients with blunt chest trauma and pulmonary contusions

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Abstract

Severe pulmonary contusions occur in blunt chest trauma, especially with high velocity injuries. Pulmonary contusions following trauma may result in significant hypoxemia and decreased compliance which may progress over several days. Extensive contusions may result in respiratory difficulty or progress to adult respiratory distress syndrome, which increases mortality. We decided to review the cases of polytrauma with associated pulmonary contusions to determine the factors which influence outcome.

Materials and Methods: A retrospective chart review of all cases of trauma with pulmonary contusions on X-ray or CT scan. The cases were examined for age, type of injuries, admission APACHE II, SAPS II and SOFA scores, PaO\(_2\)/FiO\(_2\) ratio, presence or absence of rib fractures, average positive fluid balance, average sedation dose, pulmonary haemorrhage, ventilator days, ICU days and hospital outcome.

Results: There were 18 cases of pulmonary contusions. All had associated injuries. 6 patients died, 4 in the ICU and 2 patients died 1 week after transfer to a high dependency unit, one due to sepsis and the other due to massive haemothorax. There was a significant difference in PaO\(_2\)/FiO\(_2\) ratio at admission and throughout the ICU course, fluid balance and sedation dose, but not in ventilator days and ICU days between survivors and nonsurvivors. The incidence, frequency and amount of pulmonary haemorrhage were higher in the nonsurvivors.

Conclusions: Close attention to improving gas exchange, and early management of hemoptysis might improve outcome in pulmonary contusions.

Key Words: Chest trauma, pulmonary contusion, fluid balance, hemoptysis, rib fractures.

Introduction

Pulmonary contusion following chest trauma results in pulmonary bleeding and microscopic disruption of alveoli. Pulmonary contusion is reported to be present in 30% to 75% of patients with significant blunt chest trauma, most often from automobile accidents with rapid deceleration.\(^1\) Pulmonary contusion can also be caused by high-velocity missile wounds and the passage of a shock wave through the tissue.

In young people, the compliant chest wall usually returns to normal without fracturing the ribs. With increasing age, rib fractures are more common. Patients may initially have minimal respiratory compromise due to the injury only to develop progressive respiratory dysfunction and adult respiratory distress syndrome\(^2\) (ARDS) over several days. Alternatively they may present in respiratory difficulty and rapidly progress to ARDS.

Pulmonary contusions must be suspected in blunt trauma to the chest with rib fractures and hemoptysis.

Hypoxemia is caused by ventilation-perfusion mismatching, resulting from collapsed or edema-flooded alveoli. Early diagnosis and treatment are important and
the traditional management of pulmonary contusion has included a degree of fluid restriction. Animal models of isolated pulmonary contusion showed that large volumes of fluid or administration of colloids may worsen lung injury due to extensive flooding of the alveoli. However, this has not been substantiated in clinical studies.³

We decided to review the cases of pulmonary contusion admitted in our multidisciplinary intensive care unit to analyse the factors which may have contributed to poor outcome.

**Materials and Methods**

A retrospective chart review was done on all patients with blunt chest trauma, admitted between Feb 2002 and Oct 2004. Institutional review board approval was sought and we were informed that it was not required, since this was an observational study. Records were reviewed for demographics, need for mechanical ventilation, fluid requirements, and hospital course.

Data on survivors and nonsurvivors were analysed and the following variables were measured: age, the APACHE II, SAPS II and SOFA scores; the PaO₂/FiO₂ ratios on day 1, 3, 5, 8, 10, and 15; the mean positive fluid balance per day; the use of colloids, presence of rib fractures, associated injuries, the number of days on sedation; the mean daily sedation dose; the ventilator days and ICU days. Post mortem examination was done on all patients who died.

Statistical analysis was by chi square test.

**Results**

There were 18 patients with lung contusions, all data are shown in Table 1.

Six patients died and the rest survived.

Four patients died in the ICU with refractory hypoxia. Two patients had severe head injuries as well. Of the two patients who died in the HDU, one patient died of massive hemothorax (postmortem revealed a lung laceration and continued bleeding), and the other patient died of sepsis.

Demographic data revealed that the age of the patients ranged from 19-75 years.
There were only two females in the entire group.

The mechanisms of injury were:

- Head-on collision with heavy vehicles at high velocity
- Hit and run accidents (pedestrian struck by vehicle)
- Fall from height or blunt injury to the chest due to fall of heavy machinery on the chest.

Associated injuries included multiple rib fractures in all except two survivors; long bone fractures, abdominal injuries including splenic rupture, liver lacerations, pelvic fractures and head injury. Two nonsurvivors had major head injuries.

The mean age of non survivors was higher than survivors, (mean age 46.33 in nonsurvivors compared to 36.6 in survivors $P < 0.05$).

There were two patients older than 65 years.

Postmortem on the nonsurvivors revealed hemothorax in all six patients; severe pulmonary contusions in four patients and lung lacerations in two patients along with associated injuries. Two patients had intracerebral bleeds.

The admission $\text{PaO}_2/\text{FiO}_2$ ratio as well as the mean $\text{PaO}_2/\text{FiO}_2$ ratio throughout the ICU stay was lower in nonsurvivors. (Figures 1 and 2)

In some patients the admission chest Xray was normal, and worsened during the subsequent days (Figure 3-5). Others had infiltrates on the admission X-ray. All nonsurvivors were classified as having ARDS and were severely hypoxic at the time of death.

Nonsurvivors were more severely injured with higher admission mean APACHE II (14 vs 7 $P = 0.03$) and SAPS II (40 vs 26 $P = 0.007$) scores. However, the mean SOFA scores were not significantly different (nonsurvivors 5.83 and survivors 3.83).

Nonsurvivors had lower mean $\text{PaO}_2/\text{FiO}_2$ ratio throughout the ICU stay than survivors, (158 vs 245 $P < 0.05$) indicating worse lung injury.

There was a increased incidence of hemoptysis, positive fluid balance, increased morphine requirement and higher APACHE II and SAPS II scores in nonsurvivors. These values were statistically significant. There was no difference in crystalloid or colloid use, ventilator days or ICU days between survivors and nonsurvivors.

**Discussion**

Blunt trauma to the chest in high velocity accidents causes rib fractures and contusion of the underlying lung. Contusions are usually suspected in the presence of rib fractures and hemoptysis. Intra-alveolar hemorrhage can progress to ALI/ARDS which can increase mortality due to severe hypoxia.

Pulmonary contusion can generate worsening gas exchange, which may persist in spite of adequate ventilatory management. Despite advances in pulmonary care and ICU management, pulmonary contusion contributes to higher mortality and morbidity for patients with other severe injuries.$^1$

Our results showed that the mean age of survivors (36.6 years) was statistically lower than of nonsurvivors (46.6 years). This is not surprising as it is well known that the elderly patient does not tolerate major chest trauma.$^4$
There was a significant difference in the mean daily positive fluid balance between nonsurvivors and survivors (1075 ml vs 488 ml $P = 0.007$). However, the increase in fluid balance was not due to increase in fluid intake (average fluid infused per hour was the same in nonsurvivors (162.5 ml) and survivors (159.75 ml $P > 0.05$) but was probably related to worse hemodynamics and lower urine output (mean hourly urine output of 80 ml/hour in nonsurvivors vs 128 ml/hour in survivors). Whether the positive fluid balance and consequent increase in extravascular lung water worsened the lung injury and hypoxemia and contributed to mortality is unclear.

Nonsurvivors needed more sedation (mean daily morphine dose 38.3 mg vs 22.9 mg) than survivors. In addition to the pain of rib fractures and associated injuries, the increased need for sedation could have been due to the hypoxia of severe lung injury necessitating more sedation for ventilatory management, as well as the higher incidence of head trauma in nonsurvivors.

The incidence of significant hemoptysis was higher in nonsurvivors (66% vs 33%). This could have been another factor contributing to mortality.

It has been suggested that significant hemoptysis should be controlled with single lung ventilation. It has been reported that lung isolation procedures may be required in 33% of patients with airway bleeding.\(^5\)

Emergency thoracotomy and control of bleeding is another option.

Would our mortality have been lower if we had undertaken these measures?

The ultimate outcome after major trauma is multifactorial and any single intervention such as lung resection has not been known to reduce mortality. Thoracotomy following blunt injury resulted in three times the mortality seen in patients with penetrating injury and most likely reflects the multisystem involvement in blunt force injuries.\(^6\)

All our nonsurvivors were severely hypoxic. All patients were ventilated with pressure control mode of ventilation with the following strategies to improve oxygenation:
Inverse ratio ventilation, PEEP and recruitment strategies and prone positioning were used whenever feasible. Patients with pelvic fractures, head injuries or unstable fractures were not turned prone.

When the above measures fail, two strategies have shown improvement in oxygenation in patients with lung contusions and refractory hypoxia. These include individual lung ventilation with a double lumen tube\textsuperscript{7} and high frequency jet ventilation.\textsuperscript{8}

Canella et al\textsuperscript{7} hypothesized that in unilateral lung contusion, each lung would have a different compliance and equal tidal volumes would result in vastly different airway pressures; overdistending one lung and underventilating the other. Separating the lungs and ventilating each lung at different tidal volumes to set the plateau pressures < 26 cm H\textsubscript{2}O to prevent barotrauma would lead to better gas exchange. 12 patients with chest trauma and unilateral lung contusions were ventilated in this manner with vast improvements in both PaO\textsubscript{2} and PaCO\textsubscript{2}.

High frequency jet ventilation also dramatically increased the PaO\textsubscript{2} in life-threatening hypoxia following bilateral lung contusions.\textsuperscript{8}

Unfortunately we did not undertake any of these measures due to nonavailability of high frequency jet ventilation, and poor visualization of the airway due to bleeding, limiting the insertion of double lumen tubes.

Vidhani et al\textsuperscript{9} reported good outcome in patients with pulmonary contusions with noninvasive ventilation. They questioned the validity of strictly following ATLS guidelines which mandate invasive ventilatory support for all trauma patients with hypoxia. This needs to be explored further.

Our study has several limitations. Being a retrospective chart review, we could not standardize several interventions such as prone positioning, alveolar recruitment, etc.

However, the main inference from the study is that blunt trauma and pulmonary contusions can have a considerable mortality especially in the face of severe hypoxemia, and measures to limit hypoxia should be undertaken early. Early institution of one lung ventilation in the event of bleeding and hypoxia should be a consideration.

References