Mild, moderate or severe lung injury after trauma: what are the early predictors?

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Introduction

Lung injury is a common complication following major trauma. Acute lung injury (ALI) and its more severe form, acute respiratory distress syndrome (ARDS), can result from direct or indirect pulmonary damage caused by traumatic injury. [1] Lung injury is characterised by progressive dyspnoea and hypoxaemia with corresponding chest radiography changes. [2] Several definitions have been proposed, to assist with diagnosis [3], including the Murray Lung Injury score. [4] Large volume blood transfusions, thoracic injury, pulmonary contusion, and hypoperfusion have previously been associated with its development. [5] However, early predictors of differing grades of lung injury following trauma are yet to be described.

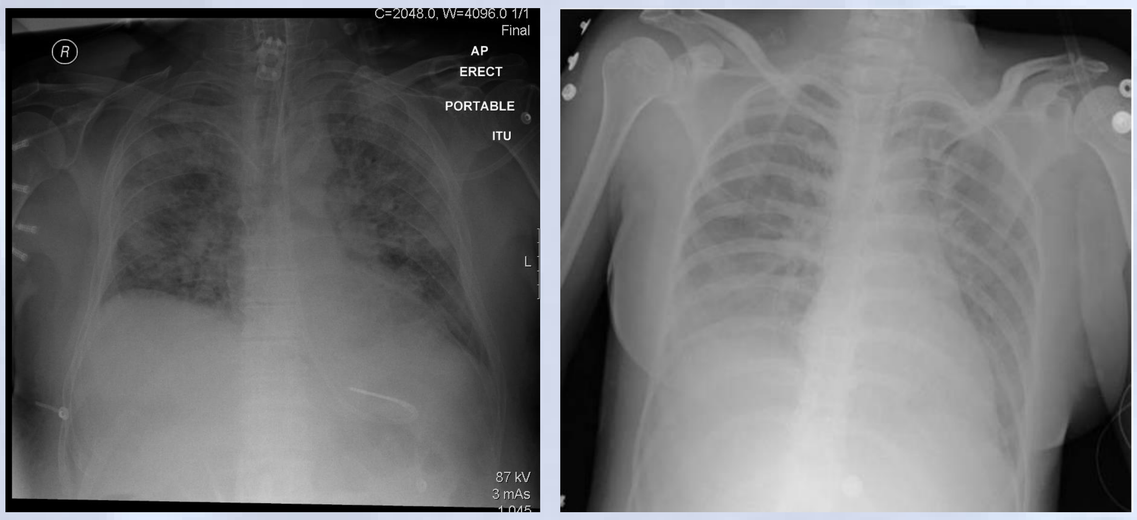

***Image 1**. (**LEFT**) Severe lung injury at day 4 post Road Traffic Collision (major haemorrhage protocol activated on admission). (**RIGHT**) Transfusion related acute lung injury. [6]*

Objectives

The primary objective of this study was to characterise the admission risk factors associated with differing severity of lung injury after trauma. Secondarily, we wished to evaluate the relationship between severity of lung injury and outcomes.

Materials and Methods

- Retrospective analysis of prospectively collected data from adult trauma patients (>15 years old) enrolled to the ACIT2 study over a five-year period at an urban Major Trauma Centre.
- ACIT2 is an on-going prospective study of 2,800 patients evaluating coagulation and inflammation in trauma. [7]
- Lung injury was defined using the Murray Lung Injury (MLI) criteria (see *Table 1*). [4]
- Mild-moderate lung injury (MMLI) was defined as a MLI score of 0.1-2.5, and severe lung injury (SLI) as a score of >2.5.
- Nonparametric data was analysed using Kruskal-Wallis tests and percentages analysed using Chi-squared test. Multivariate analysis was used to identify independent predictors of lung injury.
- The variables entered into the multivariate model were: age, mechanism of injury, thoracic injury, AIS thorax, ISS, admission lactic acidosis (lactate ≥5 mmol/L), admission lactate, admission base deficit, admission INR, packed red blood cells 0-24Hr, major haemorrhage protocol activation (≥ 10U), fresh frozen plasma 0-24Hr.

Chest Radiograph Score	Points	Hypoxaemia Score	Points
No alveolar consolidation	0	PaO_2/FiO_2 ≥ 39.9	0
Consolidation in one quadrant	1	PaO_2/FiO_2 29.9-39.8	1
Consolidation in two quadrants	2	PaO_2/FiO_2 23.3-29.8	2
Consolidation in three quadrants	3	PaO_2/FiO_2 13.3-23.2	3
Consolidation in four quadrants	4	PaO_2/FiO_2 <13.3	4
PEEP Score	N/A		
Compliance Score	N/A		

***Table 1.** Lung injury Score. The table demonstrating the Murray Lung Injury Scoring system used. Only the chest radiograph and hypoxaemia scores were included, since the PEEP and Compliance scores were not available. Final value was obtained by dividing the aggregate sum by the number of components used: 0 – no lung injury; 0.1-2.5 - mild to moderate injury (equivalent to ALI); >2.5 – severe lung injury (equivalent to ARDS).*

Results

812 patients enrolled into the ACIT2 study with 311 admitted to critical care. 145 (47%) developed MMLI and 47 (15%) developed SLI. Median time to MMLI was 4 days (IQR 2-6) and SLI 6 days (IQR 4-9), (p<0.01).

Patients who developed SLI were more severely injured (ISS 33 vs 29, p<0.01), (AIS thorax 4 vs 3, p<0.01) and more shocked on admission (base deficit 4.9 vs 3, p=0.01). Independent risk factors associated with SLI were older age (OR 1.07, p<0.01) and injury severity (OR 1.14, p<0.01).

The incidence of chest infections was higher in the SLI group (77% vs 54%, p<0.01). The severity of lung injury was not associated with increased mortality rates or transfusion requirements. Patients with SLI spent longer time in critical care (Days 12 vs 7, p<0.01) and had longer ventilation periods (Days 6 vs 3, p=0.01).

Variable	Odds ratio	95% CI	p-value
Age	1.03	1.02-1.05	<0.01
ISS	1.1	1.07-1.13	<0.01
Admission BD	0.90	0.83-0.99	0.03

***Table 2**. Multivariate regression analysis of admission variables associated with the development of mild to moderate lung injury. ISS: Injury Severity Score; BD: Base Deficit;*

Variable	Odds ratio	95% CI	p-value
Age	1.07	1.04-1.1	<0.01
ISS	1.14	1.07-1.2	<0.01

***Table 3**. Multivariate regression analysis of admission variables associated with the development of severe lung injury. ISS: Injury Severity Score.*

	MMLI (n=145)	SLI (n=47)	p-value
Mortality, (%)	22 (15)	11 (23)	ns
Chest Infection, (%)	79 (54)	36 (77)	<0.01
Ventilation days‡	3 (1-8)	6 (3-13)	0.01
Ventilator-free days‡	25 (20-27)	22 (15-25)	0.01
CC LOS‡	7 (4-13)	12 (7-17)	<0.01

***Table 4**. Outcomes. Values are expressed as median (IQR: Interquartile range) ‡ or n (%). CC LOS: critical care length of stay.*

Conclusions

Older age and increased injury severity were the only independent predictors of mild to moderate and severe lung injury in this cohort of patients. Severity of lung injury was not associated with mortality in this study, but did increase the incidence of chest infections, prolonged the critical care length of stay and ventilation periods.

1. Niesler U, Palmer A, Radermacher P, et al. Role of alveolar macrophages in the inflammatory response after trauma. Shock. 2014; 42(1):3-10
2. Ware LB. Pathophysiology of acute lung injury and the acute respiratory distress syndrome. Semin Respir Crit Care Med. 2006; 4(27): p. 337-349.
3. Raghavendran K, Napolitano LM,. ALI and ARDS: Challenges and Advances. Crit Care Clin. 2011 July; 27(3): p. 429-437.
4. Murray JF, Matthay MA, Luce JM, Flick MR,. An expanded definition of the adult respiratory distress syndrome. Am Rev Respir Dis. 1988; 3(138): p. 720-723.
5. Miller PR, Croce MA, Kilgo PD, Scott J, Fabian TC. Acute respiratory distress syndrome in blunt trauma: identification of independent risk factors. Am Surg. 2002, 68 (10); 845-50.
6. Haji A G, Sharma S, Vijaykumar DK .Transfusion related acute lung injury presenting with acute dyspnoea: a case report *Journal of Medical Case Reports* (2008), 2:336
7. Davenport R, Manson J, De'Ath H, et al. Functional definition and characterization of acute traumatic coagulopathy. Critical Care Medicine. 2011, 39 (12); 2652-2658.