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ORIGINAL ARTICLE

Continuous positive airway pressure ventilation versus Bi-level positive airway pressure ventilation in patients with blunt chest trauma

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KEYWORDS

Chest trauma;
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Abstract *Introduction:* The use of positive pressure ventilation has decreased the overall morbidity and mortality associated with blunt chest trauma, but invasive mechanical ventilation (IMV) is associated with many complications. The role of noninvasive ventilation (NIV) for the management of patients with blunt chest trauma has not been well established. The aim of this study was to compare the efficiency of CPAP versus BiPAP in avoiding IMV.

Patients and method: This study was carried out in the period between April 2011 and April 2103, on 40 patients admitted to ICU with blunt chest trauma with acute respiratory distress that had deteriorated despite aggressive medical management. Patients were randomly assigned to receive either continuous positive airway pressure ventilation (CPAP) (group 1) $n = 15$, Bi-level positive airway pressure ventilation (BiPAP) (group 2) $n = 15$ or IMV (group 3) $n = 10$.

Results: Improvement in gas exchange and relieve of respiratory distress was noticed in the three studied groups after the start of assisted ventilation. Four patients in group 1 (26.7%) and three patients in group 2 (20%) required endotracheal intubation. There was no significant difference in the length of stay in ICU between the three groups (10 ± 5 days in group 1, 11 ± 4 in group 2 and 10 ± 6 in group 3. Pneumonia developed in one patient in group 1 (6.6%) and in 2 patients in group 2 (13.3%) and in 3 patients in group 3 (30.3%). Pneumothorax developed in one patient in group 1 (6.6%) and in no patients in group 2 (0%) and in one patient in group 3 (10%). As regards mortality no mortalities were observed in groups 1 and 2 but one patient in group 3 (10%) died.

Conclusion: Both CPAP and BiPAP are safe and efficient techniques in managing respiratory failure and reducing the incidence of intubation in patients with blunt chest trauma.

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Introduction

Chest trauma is one important factor for total morbidity and mortality in traumatized emergency patients. The lethality of isolated chest traumas is about 5–8%. Up to 25% of all deaths caused by trauma are related to chest injuries [1], and mortality dramatically increases as a function of increased chest trauma force [2].

Chest injuries often occur in combination with other severe injuries, such as extremity, head, brain and abdominal injuries [1]. The impact of a blunt trauma is typically conducted to many different intrathoracic structures; hence nearly all organs of the thoracic cavity can be involved in chest trauma. The most common types of damage that result from chest trauma include injuries to the ribs, lung contusion, hematoma of the chest wall, pleural effusion, pneumothorax and haemothorax [3].

Pathophysiological aspects

Respiratory impairment: damage to the osseous structure of the thorax by rib and sternum fractures destabilizes the rib cage and impairs spontaneous breathing mechanics substantially; this condition is amplified by pain, which further reduces breathing function. Direct traumatic damage to the lung leads to an extravasation of protein-rich fluid with an altered surfactant composition [4]. Disturbance of diffusion, the reduction of compliance and functional residual capacity, ventilation–perfusion mismatch and intrapulmonary shunt develop with subsequent reduced oxygenation and elevated $PaCO_2$ levels [5,6]. After severe chest trauma, intrapulmonary shunting can also be caused by a disruption of pulmonary capillaries and extravasation into the alveolar spaces. Aspiration of blood and/or gastric contents, fat embolism to the lung due to long bone fractures and systemic inflammatory response syndrome may additionally exacerbate respiratory deficits and may lead to acute respiratory distress syndrome (ARDS) [7].

Cardiovascular impairment: a reduction in normal intraventricular filling by tension pneumothorax, pericardial tamponade or massive hemorrhage may result in a life-threatening reduction in cardiac output. Moreover, intracardiac structural damage or heart contusions with concomitant arrhythmias are additional contributors to reduced cardiac output [6].

Management of patients with blunt chest trauma focuses on interventions such as the stabilization of fractures, pulmonary toilet, effective physiotherapy, and early and adequate pain control [8,9]. These patients are at high risk for developing respiratory failure [10] with reports of up to 20% of patients with blunt chest trauma developing acute lung injury (ALI) or acute respiratory distress syndrome (ARDS) [8]. Intubation rates range from 23% to 75% and depend on the severity of the trauma, the degree of the underlying lung disease, and the intensity of initial management and monitoring [8,11]. The use of positive pressure ventilation has decreased the overall morbidity and mortality associated with blunt chest trauma, but endotracheal intubation and mechanical ventilation are associated with a high risk of nosocomial pneumonia and prolonged mechanical ventilation [12].The role of noninvasive ventilation (NIV) for the management of patients with blunt chest trauma has not been well established [13]. The aim of this study was to compare NIV (CPAP and BiPAP) with invasive mechanical ventilation (IMV) in management of patients with blunt chest trauma and to compare efficiency of CPAP versus BiPAP in avoiding intubation and IMV.

Patients and method

This clinical study was carried out on 40 patients admitted to intensive care unit with blunt chest trauma (either isolated chest trauma or as a part of polytrauma) in the period between April 2011 and April 2013. The inclusion criteria were acute respiratory distress that had deteriorated despite aggressive medical management, including severe dyspnea at rest, a respiratory rate greater than 35 breaths per minute; and the partial pressure of arterial oxygen (PaO_2) less 60 mmHg while the patient was breathing oxygen through a Venturi mask with FiO_2 up to 60%; and active contraction of the accessory muscles of respiration or paradoxical abdominal motion.

Patients with any of the following were excluded: tracheal intubation indicated for any other reason, contraindication for non-invasive ventilation (active gastro-intestinal hemorrhage, low level of consciousness, multiorgan failure, airway control problems, hemodynamic instability), traumatic brain injury, facial trauma, skull base fracture, orbit base fracture, cervical injury with specific treatment contraindicating a facial mask [10].

All patients were subjected to

- Complete medical history.
- Clinical examination.
- Laboratory investigations (renal and hepatic function tests, serum electrolytes, blood sugar ,complete blood count, arterial blood gas analysis, and microbiological investigations when pneumonia was suspected).
- Radiological investigations (plain X ray and computed tomography on the chest for all patients and for other body parts as indicated).
- The Injury Severity Scale (ISS): was evaluated as the measure of anatomic injury for six body regions: (1) the head-neck, (2) the face, (3) the thorax, (4) the abdomen-pelvis, (5) the extremities and (6) the external. The ISS was calculated as the sum of the squares of the highest abbreviated injury scale grade in each of the three most severely injured body regions [14].
- Simplified acute physiologic score (SAPS) was calculated, this score takes into account 14 variables (age, heart rate, systolic blood pressure, body temperature, respiratory rate or need for ventilatory support, urinary output, white-cell count, hematocrit, Glasgow coma score, and serum glucose, potassium, sodium, bicarbonate, and urea nitrogen concentrations). A range of 0–4 is assigned for each variable (range of possible scores, 0–56). Higher scores indicate a higher risk of death [15].

Patients were randomized to receive CPAP (group 1) $n = 15$ (11 males, 4 females with mean age 31.8 ± 13.8), BiPAP (group 2) $n = 15$ (10 males, 5 females with mean age 31.8 ± 13.1), and patients who met inclusion criteria but did not show cooperation received IMV (group 3) $n = 10$ (7 males, 3 females with mean age 30.6 ± 12.7).