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REVIEW

Understanding of flail chest injuries and concepts in management

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ABSTRACT

Flail chest in thoracic injuries can be a cause of concern, as in the presence of associated injuries; it carries high morbidity and mortality. Flail chest injuries usually result from deceleration injuries and may be associated with sternal fracture, aortic and tracheobronchial disruption. Flail chest influences the morbidity encountered in multiple injured patients. The clinical presentation of the flail chest depends on the size of the flail segment, the intrathoracic pressure gradient during breathing, and the associated injury to the lung and thoracic wall. Treatment of these patients depends on the physiologic impairment caused by the flail segment and the severity of other associated injuries.

Key words: Flail chest, rib fracture, blunt chest trauma

Introduction

In the victims of road traffic accidents, blunt thoracic trauma is one of the most important injuries [1,2]. Elderly population (because of fragility of bones) has increased risk to sustain chest injuries including flail chest even after minor trauma, in contrast to these children (ribs are more flexible) have less risk of flail chest (only 1%) [3]. Thoracic injuries are the cause of death in approximately one-quarter of all trauma victims and influence the morbidity encountered in multiple injured patients [4-6]. Flail chest in thoracic injuries carries high morbidity and mortality (ranging from 5% to 36%) [7-12].

Pathophysiology

Flail chest results from deceleration injury and can be associated with life-threatening aortic disruption, tracheobronchial disruption, and sternal fracture [13-15]. The anatomical basis of the flail chest is the presence of multiple rib fractures. When a series of adjacent ribs is fractured in two places (anteriorly and posteriorly) because of a blunt trauma that segment of the chest wall (the flail) may lose its mechanical continuity with the rest of the thorax. The flail section of the chest wall becomes unstable and moves inward during inspiration [16]. A flail segment of the chest wall can lead to inefficient ventilation, pulmonary contusion, and atelectasis resulting in derangement of ventilation function and gas exchange [16].

Although there have been many advances in the management of major chest trauma-related injuries, the flail chest still continues to be an important topic of discussion, and this injury is associated with significant complications [5,13,17]. The excessive mobility of the flail segment not only causes significant pain but also leads to inefficient ventilation, inability to cough leading to accumulation of tracheobronchial secretions with its sequel. The associated pulmonary contusion can produce arteriovenous shunting and alters the alveolar ventilation-perfusion ratio resulting in hypoxemia and respiratory distress [18].

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Clinical Features

The clinical features of the flail chest depend on the severity of physical impact, size of the flail segment, intrathoracic pressure gradient during ventilation, and the extent of damage to the lung and thoracic cage. The cardiac deficit may also develop in these patients (tamponade due to injury to the heart) caused by an anterior flail segment [19] or a cardiac injury - usually contusion [20]. Rarely, a valvular or myocardial rupture may also occur [20,21].

Management

In literature, the treatment of flail chest still remains controversial [14,22,23]. Patients with flail chest and multiple injuries present with shock will require control of the airway preferably by endotracheal intubation [24]. Traditional management focuses on treatment of the flail segment to ameliorate the flail respiration or on treating the underlying pulmonary contusion to improve gas exchange [25]. Treatment of the flail chest depends on the severity of the ventilation dysfunction and physiologic impairment (attributable to the flail segment) [16]. Methods available for stabilizing a flail chest include surgical stabilization, treatment in a respirator (physiologic stabilization), or a combination of both. Surgical fixation may decrease morbidity, but conservative treatment with positive pressure ventilation is recommended when there are multiple injuries to other intrathoracic organs [16].

Conservative Management

With the advancement in intensive care techniques, the management of the flail chest has evolved considerably over

the recent years [17]. Conservative management of a flail chest comprises maintenance of positive intrathoracic pressure to assist the spontaneous ventilatory effort of the patient and reduce the dissynchronous movement of the flail, thus helping the lung expansion [17].

Pain Control

Adequate pain relief followed by aggressive chest physiotherapy and secretion removal can help patients to be managed safely without ventilatory support [22]. Alternatively, regional anesthesia and analgesia has been used over systemic narcotics (needs to used carefully in the elderly patients) and use of epidural analgesia has shown to improve lung volumes and ventilatory function [16,26,27]. Alternatives to epidural analgesia include the intrapleural injection of a local anesthetic and the performance of intercostal blocks. Contraindications include thoracic spine injury and coagulopathy.

Ventilation

Patients with flail chest should not be automatically subjected to tracheostomy and mechanical ventilation [24]. Patients with a traumatic brain injury or who develop pneumonia or have other septic complications and multiple organ failure may require prolonged ventilation and tracheostomy [14,24,28]. In cases of isolated chest trauma, prolonged positive pressure ventilation may not be ideal. The choice of the ventilation mode depends on the patient's clinical status as well as the personal experience of the intensivist [16].

Surgery

Flail chest needs emergency surgical attention and various methods have been described in literature to stabilize the unstable flail segments, namely, surgical stabilization, treatment in a respirator (physiologic stabilization), or a combination of both [29]. Although recently surgical procedures have been mentioned to decrease the mortality and morbidity rate by some authors [30,31], operative fixation has not yet been widely accepted [25]. Tanaka et. al. [31] have recommended surgical stabilization for flail chest patients who have anterolateral flail segment and respiratory failure (without severe pulmonary contusion), pulmonary contusion with persistent instability of the chest wall, nonintubated patients with deteriorating pulmonary function. The obvious indication for a surgical approach is an internal injury requiring a thoracotomy. Some surgeons routinely perform open fixation of flail chest when a thoracotomy is undertaken for other indications [1,25]. It is the recommended and correct approach; however, surgical intervention should also be considered in patients with excessive paradoxical movement, deteriorating clinical status, or unremitting pain [10].

Supportive Care

It is necessary to drain the hemo/pneumothorax by intercostal drainage by placement of chest tubes in improving the respiratory status of these patients [32,33]. Aggressive chest physiotherapy facilitating deep breathing and effective cough can facilitate recovery in lung functions. The edema associated with pulmonary contusion can be controlled by fluid restriction, the use of diuretics (i.e., furosemide), which helps to reduce pulmonary interstitial fluid formation. Plasma or albumin infusions help to maintain an adequate plasma oncotic pressure and the use of methylprednisolone helps to reduce pulmonary capillary membrane permeability [17,34,35]. Use of external chest bandage can limit the respiratory movement of the chest [10].

Complications

Flail chest is a clinical diagnosis, and pulmonary complications due to flail chest include pneumothorax, hemothorax, pulmonary contusion, pneumonia, and atelectasis [9,13,14,16]. Respiratory failure after chest trauma is mainly linked to lung contusion, bronchial blood and secretions, and hemo and/or pneumothorax [11]. Contribution of flail chest to respiratory failure is usually moderate compared with lung contusion and the presence of paradoxical movement in spontaneously breathing patients can be without clinical relevance [11].

Mortality

In flail chest, mortality rate is reported between 11% and 40% [1,14,33,36,37]. However, with the advancements in the management, a decrease in mortality from 30%–40% in 1976 to 11%–60% in the 1980s has been reported [25]. In majority of the patients, associated severe injuries result in mortality [38-40]. Increasing age has been reported to influence mortality in patients with flail chest [38]. Other major causes of mortality and morbidity are respiratory failure resulting from contusion or laceration by a detached rib fragment [41]. There is high incidence of nosocomial infections and tracheostomy complications in these patients [14,42].

Conclusions

The mainstay of treatment is the relief of pain, chest physiotherapy to aggressively remove the secretions, and try to help patients to recover without ventilatory support.

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Author's Contributions

RKJ, AA conceptualized the project. RKJ, AA and YS contributed to literature search, project design and drafting the manuscript. RKJ, YS and NNS edited and critically revised the paper. All authors have read and approved the final version of the manuscript.

Competing Interests

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