Chest Wall Trauma

Sarah Majercik, MD, MBA[a,*], Fredric M. Pieracci, MD, MPH[b]

KEYWORDS

• Chest trauma • Rib fractures • Flail chest • Surgical stabilization of rib fractures

KEY POINTS

- Chest wall trauma causes significant morbidity and mortality in injured patients.
- Adequate analgesia for patients with severe rib fractures/flail chest is critical. Locoregional modalities are more effective than oral or parenteral opioids.
- Mechanical ventilation should be used for pulmonary dysfunction. Noninvasive ventilation strategies are effective.
- Surgical stabilization of severe rib fractures is beneficial in the short and long term, and should be considered in select patients.

INTRODUCTION

Chest wall trauma is common. Approximately half a million patients presented to emergency departments in the United States in 2013 with an injury to their bony thorax, and about 200,000 of those were hospitalized.[1] Reported morbidity and mortality rates after chest wall injury vary widely, but clearly increase with age and number of rib fractures.[2–5] Flail chest, generally defined as three or more ribs fractured in two or more places, carries an even higher risk of mortality,[6] and many patients who sustain flail chest suffer from long-term pain, disability, and inability to maintain employment.[7–10] Patients with flail chest often have significant pulmonary contusion, which further contributes to short- and long-term morbidity and mortality.[11,12] Although many patients who suffer chest wall trauma also have injury to soft tissue and intrathoracic structures, this article focuses on bony injuries of the ribs and sternum.

HISTORICAL PERSPECTIVE

Diagnosis and management of chest wall injury has been described as far back as 3000 BC.[13] The first modern descriptions of "stove in chest" and flail chest were published in 1945[14] and 1955,[15] respectively. Throughout the 1960s and 1970s, patients with severe chest wall trauma were managed with "internal pneumatic stabilization,"[16,17] or long-term positive pressure mechanical ventilation. In 1976, Trinkel and colleagues[18] and Shackford and colleagues[19] challenged this notion, and since that time, mechanical ventilation has been used as appropriate for pulmonary dysfunction and to correct abnormalities of gas exchange, but not as a "stabilizing" agent per se.

Over the past century, various surgical methods for repairing rib fractures have been described.[20] Despite these descriptions, treatment of severe chest wall injury has remained largely nonsurgical.[6] In the past two decades, there has been a sharp

Disclosure Statement: Dr S. Majercik has nothing to disclose. Dr F.M. Pieracci has received financial research support from DePuy Synthes (45007100), makers of the MatrixRIB fixation system.

[a] Division of Trauma and Surgical Critical Care, Intermountain Medical Center, 5121 South Cottonwood Street, Murray, UT 84107, USA; [b] Department of Surgery, Denver Health Medical Center, University of Colorado School of Medicine, 777 Bannock Street, MC0206, Denver, CO 80204, USA

* Corresponding author.

E-mail address: Sarah.majercik@imail.org

Thorac Surg Clin 27 (2017) 113–121

http://dx.doi.org/10.1016/j.thorsurg.2017.01.004

increase in interest in the surgical stabilization of rib fractures (SSRF), with several authors showing improved outcomes compared with conventional management in the most severely injured patients.[21–24] Medical device manufacturers have developed and marketed various rib-specific fixation systems, and use of surgical techniques has grown. Surgical and nonsurgical management strategies are discussed in this article.

MECHANISMS OF INJURY

In the civilian world, most injuries to the chest wall result from blunt injury. The most common mechanism of injury is motor vehicle crash, followed by pedestrians struck by vehicles, falls, and crush injuries.[25,26]

ANATOMIC CONSIDERATIONS

The ribs, sternum, clavicles, scapulae, and vertebrae are the major bony structures that comprise the chest wall. Because of the amount of energy required to fracture these bones, one must always have a heightened index of suspicion that there is underlying thoracic or abdominal visceral injury when a bony chest wall fracture is discovered.[24,27,28] An exception to this is in the elderly, where the bones are less strong, and thus, often fracture after low-energy incidents.[29] In children, rib fractures are less common because of increased compliance of the thoracic cage. Thus, if a child does sustain a fractured rib, one must have a high suspicion of severe intrathoracic or abdominal injuries.[30]

INITIAL MANAGEMENT

Identification of major chest wall and intrathoracic injuries figure prominently in the initial management, or "primary survey"[31] of the multiply injured trauma patient. After attending to the airway, breathing, and circulation, a history should be taken if possible, and physical examination focused on diagnosis of life-threating conditions rapidly performed. With specific regard to the chest wall, the examiner should observe chest rise, looking for areas of obvious asymmetry that may suggest a flail segment. The chest wall can also be palpated, with the examiner feeling for symmetry, crepitance, or perhaps mobile segments of the chest wall. Although difficult in a noisy emergency department setting, auscultation should also be performed.

In the hemodynamically stable patient with severe chest wall injury with suspected pulmonary contusion, one should be judicious with crystalloid fluid resuscitation. Although the evidence is not strong that volume of crystalloid correlates with eventual outcomes,[32] it is prudent to avoid unnecessary intravenous fluid administration.

RADIOGRAPHIC DIAGNOSIS

An anteroposterior plain chest radiograph (CXR) is still an important initial study to obtain in a major trauma patient in whom one suspects major thoracic injury, simply because it can rapidly diagnose immediately life-threatening intrathoracic pathology, such as tension pneumothorax or massive hemothorax. The endotracheal tube position can be checked, and the clinician can evaluate the pleural spaces, the mediastinum, and bones for obvious injuries. It is well-documented, however, that CXR has low sensitivity for diagnosing rib fractures and some serious intrathoracic pathology, such as pulmonary contusion.[33] Computed tomography (CT) of the chest is commonly (perhaps too commonly) used in trauma patients as a more sensitive test to definitively diagnose chest wall and/or intrathoracic injury. The CT can provide much more precise injury information, but care should be taken not to use it indiscriminately. There are published decision rules/algorithms[34,35] to help clinicians decide when chest CT is warranted. Most use a combination of patient and injury criteria that are predictors for significant thoracic injury. In cases where multiple rib fractures are suspected or diagnosed by CXR, chest CT has become standard practice to characterize all of the chest wall/intrathoracic injuries, and to evaluate whether surgical repair of the ribs is warranted.[21,24]

MANAGEMENT OF CHEST WALL INJURIES

Rib Fractures/Flail Chest

The management of patients with multiple, displaced rib fractures or flail chest consists of three basic tenets: (1) pain management, (2) management of pulmonary dysfunction, and (3) surgical fixation. Previous authors have shown that multidisciplinary protocols or clinical pathways for managing patients with multiple rib fractures yields better clinical results,[36,37] including decreased mortality, decreased pneumonia, shorter hospital and intensive care unit length of stay,[38] and less return visits to the emergency department.[39] This was found to be particularly true for patients who are older than 65.[36] Development and implementation of a clinical pathway should be considered at institutions that treat patients with severe chest wall trauma with any regularity.