Case Report

The Rule of Sternal Fractures in Life-Threatening Blunt-Chest-Trauma: Treatment and Indications for Operative Stabilization

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Abstract

Road traffic accidents frequently result in blunt-force thoracic and concomitant injuries including flail-chest and pulmonary fail. The severity and type of injury determines the treatment modalities and prognosis. We report the case of a 56-year-old car driver, who suffered a complex thoracic trauma following a frontal collision. His life-threatening injuries included a dislocated sternum fracture, multiple rib fractures and thoracic-spinal fracture as well as cardio-pulmonary contusion with bilateral haemopneumothorax (Injury Severity Score 35). We discuss the operative chest-wall strategies in context with pulmonary considerations and the literature.

INTRODUCTION

Sternal fractures are observed in high-impact-accidents [1,2]. The injury mechanism is usually either (a) a direct force to the anterior chest wall most commonly seen in frontal car collisions with steering-wheel/belt/airbag contact or (b) a flexion-compression movement of the trunk associate most often combined with rib and/or spine fractures leading to an unstable thorax [1-4]. The incidence of sternal fracture described in literature is rare and significantly different, ranging from 1.5% ~18.5% but the concomitant injuries of thoracic organs in severe chest trauma lead to a high mortality of up to 45% [1,5-7]. Unstable thorax may result in shallow tidal volumes, collapse of alveoli, arteriovenous shunting and hypoxemia, leading to pulmonary insufficiency [8]. Accompanying thoracic or lumbar spine injury was reported in up to 39.1% of patients [7,9-11]. Therapeutic strategies are still under scientific discussion concerning conservative or operative treatment including choice of implant-type and best time between trauma and surgery not only to treat the thoracic-wall but also pulmonary instability [12-16]. This paper describes a severely injured car-driver after frontal collision with pulmonary insufficiency as well as grossly displaced sternal fracture, ribs fractures and an unstable vertebral fracture.

CASE PRESENTATION

A 56-year-old male, who was generally healthy except for a cardiac arrhythmia treated by a dual-chamber pacemaker, suffered a polytrauma during road-traffic-accident. The patient drove frontally into a barricade at a speed of approximately 50 kilometers per hour, the cause being unknown. The steering wheel of the vehicle deformed and the front-airbags deployed. On presentation in our emergency department the patient was disorientated and displayed signs of intermittent somnolence (Glasgow Coma Scale 13) although there were no obvious signs for head injuries. The patient had compression pain on the left side of the chest and on the left-front pelvic region. The initial examination revealed no severe tenderness on percussion of the lumbar spine but frontal and dorsal chest pain. Apart from abrasions and bruises there were no other pathological findings. Because of progressing pulmonary and cardiovascular instability emergency care was performed according to the Advanced Trauma Life Support-guidelines [17]. Imaging modalities displayed an unstable thoracic spine fracture (T10, AO classification: type B3), a dislocated sternal fracture (Figure 1), a fracture of the left anterior arch of the pelvis (AO classification: type A2), an acetabular fracture on the left side (AO classification: type B2) (Figure 2), prepectoral subcutaneous emphysema, and a pneumomediastinum with fractures of the fifth through seventh rib. Additionally there was evident cardiac and pulmonary contusion and a bilateral haemopneumothorax. Due to these life-threatening thoracic organ injuries the value of the Injury Severity Score revealed 21 points.
Due to pulmonary insufficiency the patient was admitted directly to our intensive care unit. He was intubated and an arterial line and a central venous catheter were inserted as well as bilateral thoracic drains. The patient received rotational bed therapy (RotoRest) and catecholamines were administered. Because of the poor pulmonary function the rotational bed therapy had to be continued for 12 days before the patient was stable enough for surgery. In a single-stage operation an osteosynthesis was performed on the sternum using open reduction and internal fixation with an angle stable locking plate. The T10 spinal fracture was treated by means of percutaneous dorsal instrumentation bridging T8/T9 to T11/T12 (Figure 2). Postoperatively the pulmonary condition improved rapidly. Extubation and removal of the thoracic drains were possible during a 24 hour-period postoperatively. Four days later a second-stage surgery was performed on the acetabular fracture using open reduction and internal fixation with a Reco-Plate (9 holes) utilizing a Kocher-Langenbeck approach. 10 days after last surgery he was transferred to the rehabilitation-unit. The subsequent postoperative course showed no complications concerning wound and bone healing as well as progredient cardiac and pulmonary stabilization without infection.

**DISCUSSION**

Sternal fractures are rare and associated with high-energy impacts [1-3,6]. In combination with rib and spine fractures they commonly lead to an unstable thorax [1,5,7,18]. In most cases the sternal fracture itself is no severe injury but this fracture must be taken as a clinical sign for further life-threatening, intrathoracic cardiac and/or pulmonary organ lesions [8,9]. In accordance to the case presented, road traffic accidents are the leading cause of such injuries [1-3]. If a sternal fracture is observed, further intrathoracic injuries must be immediately excluded [6,10,19]. In case of minor thoracic wall instability like
isolated sternal fracture and minor pulmonary involvement a conservative approach consisting of pulmonary support and adequate analgesia is preferred [8]. In contrast, mechanical instability of the thoracic cavity including lung contusion result in restricted mobility of the lung with pulmonary insufficiency and subsequent need for mechanical ventilation [20,21]. This pathology is associated with increased rates of pneumonia and sepsis. The need for an operative stabilization of the thorax wall including the sternum because of thoracic and pulmonary instability is still under scientific discussion [9,16]. Some authors described pulmonary insufficiency as a result of lung contusion and concluded that operative thoracic stabilization of the thoracic wall does not contribute to pulmonary improvement or should only be performed when other intrathoracic procedures are anyhow necessary [16]. In contrast Ahmed and Mohyuddin reported already 1995 that patients with thoracic stabilization showed reduced mean ventilation time of 4 days compared to patients without stabilization having mean ventilation time of 15 days [22]. Similar results were confirmed some years later by Voggenreiter et al. and several other authors [7,12,13]. Berg described already in 1996 the anterior wall with sternal-rib-complex as the “fourth column” of the spine and highlighted thereby the biomechanical necessity of a fixed sternum in order to achieve a stable chest [23]. Until today many different sternal osteosynthesis techniques are described but high-profile implants like non-fixed-plates and nails showed relatively high mechanical complication rates [5,12,24]. Recently Krinner et al., published good sternal stabilization results by the use of a doubled plate-system [13]. Additionally, low-profile fixed angle-plates are on the market having excellent fixation values and were therefore used in our study [25,26].

In summary, in case of severe chest injury with bony and pulmonary instability surgeons have to balance between the potential perioperative negative effects of chest/sternal osteosynthesis like bleeding, wound infection, anesthesiological or metal-associated complications and the potential positive effects of optimized ventilation, pulmonary recovery and reduced respiratory complication-rate like pneumonia [12,13,23]. Numerous authors reported post-chest-stabilization a reduced morbidity and mortality of severe injured patients [7,25,27]. In the case demonstrated here, pulmonary insufficiency caused by blunt-chest-trauma-bilateral haemopneumothorax because of unstable thorax with fractures of sternum, ribs and thoracic spine.
ameliore rapidly only after chest stabilization including sternal plate-fixation. Thereby, within 24 hours postoperatively the patient could be extubated and recovered without complication after low-profile single locking plate sternal fixation and stabilization of the 10th thoracic vertebra with an internal fixator.

In conclusion, we suggest operative stabilization of the chest wall by trauma surgeons in case of unstable thoracic injury with sternal fracturess not only to treat mechanical instability but also to treat and/or prevent the development of pulmonary insufficiency in case of initial respiratory problems as early as this patient’s status allows. Thereby, the sternal fracture should be reduced and stabilized by a low-profile locking plate as well as additional biomechanical problems like spine fracture must be addressed.

REFERENCES


