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Treatment of air leak in polytrauma patients with blunt chest injury

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ABSTRACT

Introduction: Precise diagnostics and an adequate therapeutic approach are mandatory in the treatment of air leak in polytrauma patients with blunt chest trauma. The aim of this study was to evaluate the incidence, characteristics, and management of air leak following this injury pattern.
Patients and methods: Data from 110 polytrauma patients was collected retrospectively. Fifty-four patients received initial treatment by chest tube placement for pneumothorax. These patients were classified into two groups, one with severe air leak and one with minor air leak. An evaluation of injury pattern, chest wall injuries in particular, duration of air leak, reason for drainage maintenance in place, hospital length of stay, ICU stay, ventilator duration, type of treatment, and the delay to surgical intervention was performed.
Results: Whereas 4 patients showed severe air leak and were subsequently scheduled for timely surgical intervention, the remaining 50 patients only showed minor air leak. Only 7 patients with minor air leak suffered from prolonged air leak (>5 days), which spontaneously resolved in all of them after a mean duration of 7.7 days (range 6–12 days). Absence of a prolonged air leak resulted in a shorter length of stay and a shorter duration of mechanical ventilation, although no statistical significance was observed.
Conclusions: Early spontaneous cessation of most minor air leaks as well as early surgical intervention for severe air leak lead to very satisfactory patient outcomes with a relatively short hospital stay in our patients. We therefore advocate early surgery for lacerations of the pulmonary parenchyma resulting in severe air leak, whereas minor air leaks can usually be treated conservatively.

Introduction

Pneumothorax occurs in 30–40% of polytrauma patients with blunt chest trauma and is most commonly associated with laceration of the lung parenchyma [1–4]. Considering the resulting potential for complications, high morbidity and mortality rates are not uncommon in these patients [3,4].

In most cases, the placement of a chest tube is sufficient for the management of significant pneumothorax and the drain can usually be removed without any further intervention within a short period of time. However, the management of severe air leaks is much more demanding since surgical intervention with repair or resection of the involved lung parenchyma and, where necessary reduction and stabilization of the often displaced rib fractures involved may be required [5,6]. Another possible problem is the presence of a prolonged air leak, defined as a persisting air leak for >5 days, which is thought to be associated with more severe lung lacerations and has shown to often result in significantly prolonged hospital stays [7]. The best treatment of this condition, regarding the optimal timing and type of surgical intervention, remains debated in the literature [1,4,6].

The objective of this study was to evaluate the incidence, characteristics, and treatment of air leak in a population of polytrauma patients with blunt chest injury.

This study was approved by the local ethics committee.

Patients and methods

A retrospective study of polytraumatized patients with blunt chest trauma treated at our academic, level-1 trauma center between June 2012 and June 2014 was conducted. The inclusion criteria were: 1.) significant traumatic pneumothorax (measuring

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>2 cm from the lung surface to the chest wall) that was treated by primary chest tube placement, 2.) polytrauma patients with an Injury Severity Score (ISS) ≥ 16, 3.) relevant blunt injury of the chest (i.e. $AIS_{thorax} \geq 3$) and 4.) age ≥ 16 years. Secondary chest-tube placement (after a thoracic surgical procedure or due to worsening occult pneumothorax) was an exclusion criterion. Cases of pneumothorax due to tracheobronchial rupture and patients suffering from a large vascular rupture were also excluded. Furthermore, patients with minimal pneumothorax receiving no invasive therapy, patients undergoing immediate resuscitative surgery including thoracotomy at admission and patients who suffered from severe chronic obstructive pulmonary disease (Gold stage III or IV) were not included in this study.

The following relevant data at the time of admission was evaluated: age, sex, injury pattern, Injury Severity Score (ISS), and thoracic Abbreviated Injury Scale (AIS_{thorax}). Any injury of the chest wall and intrathoracic organs was recorded. Serial rib fractures were defined as fractures of three or more adjacent ribs. In addition, a detailed evaluation was conducted of data about the duration of chest drainage, reason for drainage maintenance in place, hospital length of stay, duration of ICU stay, ventilator duration, type of surgical treatment, and the time from admission to an operative intervention. Contingent upon the severity of air leak, patients were divided into two groups. The severe air leak (SAL) group included patients in whom an almost continuous stream of bubbles was seen in the underwater seal after chest tube placement with no suction applied to the system. The minor air leak (MAL) group included individuals in whom only single bubbles were passing the chest tube's underwater seal. In this group, an air leak persisting for more than five days was defined as a prolonged air leak [5]. According to this classification, patients in the MAL group were further subclassified into two groups of interest. In the minor air leak – short lasting (MALS) group, chest tubes were removed within 5 days after early cessation of air leak. In the minor air leak – prolonged (MALP) group, chest tube removal was performed on the sixth day or later.

Chest-tube placement criteria and technique

Apical pneumothoraces smaller than 2 cm (as measured from the lung apex to the chest wall) were treated conservatively with consequent oxygen supplementation (2–6 L/min) and periodical radiographic monitoring of the pneumothorax until complete remission. In all other pneumothoraces, a tube thoracostomy was performed (24 or 28 French (if concomitant hemothorax was suspected)), and the tube was connected to an underwater seal system, thereby also gaining the advantage of monitoring for possible air leak, hemorrhage, or pleural secretion. An incision, which is big enough to allow palpation of the thoracic cavity at the tube application site ensures prevention of iatrogenic pulmonary injury during this procedure. In all cases, adequate anesthesia (including local anesthesia and, if appropriate, conscious sedation) was provided, and the procedures were performed under sterile conditions.

Management of chest tubes

The standard operating procedure at our institution requires chest tubes to remain in place for at least 24 h. Chest drains were removed if an air leak was no longer present and if pleural secretion was below 200 mL/24 h. These parameters were evaluated and documented in the patient's charts by a thoracic surgery professional every day. After chest tube removal a chest x-ray was performed to confirm complete re-expansion of the lung. No deviation from this protocol was observed in our patient collective.

Indication for surgical intervention

Primary surgical procedures to ensure an effective closure of a pulmo-pleural fistula were considered in patients with severe volume-persistent air leak which did not cease despite reduction of external suction down to zero. As described by Macchiarini et al., severe air leak was defined when a continuous stream of bubbles (versus only single bubbles in minor air leak) was observed to pass the drainage systems' underwater seal [8]. Furthermore, significant lung parenchyma lacerations observed on computed tomography (CT) were considered an indication for prompt surgery when associated with severe air leakage (Fig. 1). Chest-wall instability due to serial rib fractures and/or penetration of lung parenchyma by costal fragments was also considered an indication for timely surgical rib stabilization and perioperative pulmonary surface examination. We took a non-aggressive approach toward decision-

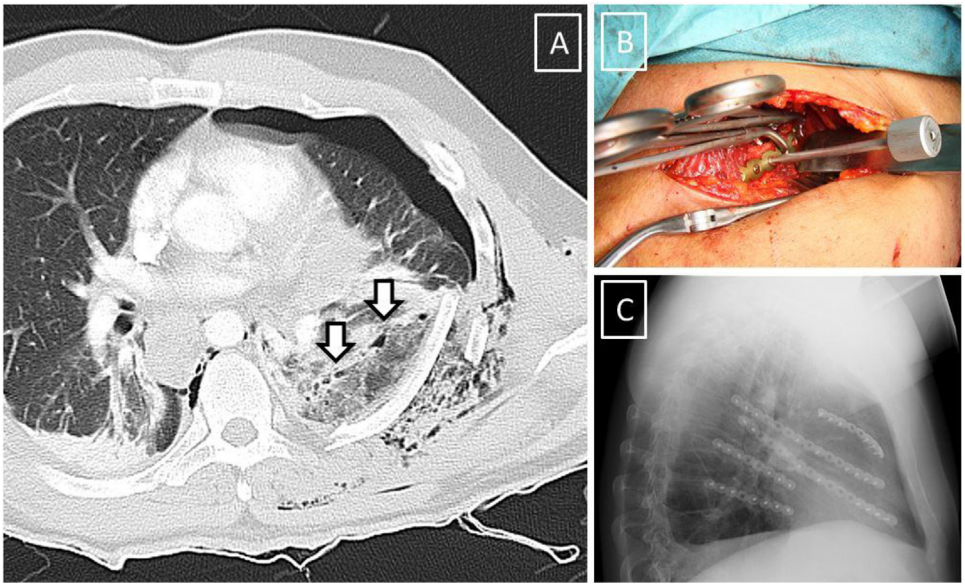

Fig. 1. A) CT-scan showing displaced rib fractures with concomitant lung laceration (arrows). B) Intraoperative picture of rib stabilization with precontoured locking plates. C) Lateral chest x-ray showing the postoperative result after surgical stabilization of flail chest.