Case report

Surgical fixation of bilateral flail segments in severe chest trauma: A clinical report and literature overview

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1. Introduction

The optimal management of patients with flail chest remains subject of extensive debate. After an era of mainly non-operative treatment we recently witness a revival in thoracic osteosynthesis. The operative fixation of rib fractures, and especially flail segments, can pose a technically challenging problem for both trauma and thoracic surgeons. In this case report we describe a successful simultaneous bilateral flail chest fixation.

2. Case presentation

A 49-year-old male was admitted to the emergency ward after a high-speed road traffic crash with significant blunt thoracic impact. His vital parameters upon hospital arrival were as follows: blood pressure 100/60 mmHg, pulse rate 120 bpm, respiratory frequency 40 per min and an oxygen saturation of 70%. Clinical examination revealed severe respiratory distress with bilateral paradoxical breathing movements. A bedside emergency chest X-ray showed a left-sided haemopneumothorax. Immediate tube thoracostomy improved his ventilation and returned his vital signs towards satisfactory levels.

Subsequent computed tomography (CT) imaging of the chest confirmed a left sided haemorthorax, bilateral lung contusions and a bilateral flail chest. Further 3D-CT reconstructions revealed fractures of all twelve ribs on the right side, with a flail segment spanning ribs 5–7. The left hemithorax suffered fractures of the first to tenth rib and a depressed flail section stretching from ribs 2 to 6 (Fig. 1A and B). Associated injuries comprised a right scapular fracture and stable fractures of vertebrae C3, C7, T1 and T2 without neurological deficits. Intracranial, abdominal and pelvic injuries were absent. This resulted in a chest Abbreviated Injury Scale of 25 and a total Injury Severity Score of 33.8

The patient was hospitalised on the intensive care unit and received epidural analgesics, oxygen supplementation, intravenous fluids, bronchial toileting and respiratory physiotherapy. A persistent hospital-acquired pneumonia was treated with antibiotics and antifungal agents. Remarkably our patient did not require any mechanical ventilatory support. He did however suffer from unrelenting pain as a result of sharp and displaced rib-ends scraping with every breath. This severe chest deformity was also considered to be a risk of chronic pain in the future or even restrictive lung disease. We therefore proceeded with a surgical stabilisation of the chest wall on day 19 post-injury.

3. Methods

3.1. Surgical procedure

After endotracheal intubation, the patient was installed in the ventral decubitus position. Head and neck were rigidly fixed considering the associated spinal injuries. The procedure was then carried out through a bilateral paraspinal posterolateral thoracotomy (Fig. 2A and B). Trapezius, latissimus dorsi and rhomboid muscles required partial division on both sides. During the procedure the scapulae were retracted anterolaterally for optimal exposure (Fig. 2C). As visualised on preoperative CT scanning, there was a marked inward displacement of both flail segments and adjacent ribs. All fractures were debrided and anatomically reduced without opening the pleural cavities.

We then performed an osteosynthesis of all accessible and unstable fracture sites. This resulted in a stable fixation of the isolated rib fractures and a conversion of the flail segments into simple anterior rib fixures. ORIF was carried out using the new Synthes CMF fixation system (MatrixRIB, Synthes CMF, West Chester, PA, USA). This is a dedicated thoracic osteosynthesis kit, consisting of precontoured titanium plates, locking screws and intramedullary splints. We preferably used the angle-stable plates and screws for optimal stability of the mostly comminuted fractures. The posterior and cephalad dissection of the left side however proved difficult, and fixation could only be achieved here using intramedullary rib splints (Fig. 2C). The procedure was completed by anatomic closure of all layers after bilateral placement of a chest drain. Total operation time was 150 min, blood loss approximately 300 cc.
3.2. Postoperative course

The postoperative course was relatively uneventful. The patient could be immediately extubated on the operating table. After three days of monitoring in the intensive care unit he could be transferred to the regular surgical ward. Intravenous analgesics, fluids and antibiotics were stopped on day 5. Right and left chest drains were removed on days 4 and 5 respectively. A recurrent left-sided pleural effusion was evacuated by means of closed thoracocentesis. The patient could be discharged home on postoperative day 13 after reassuring clinical and radiological examinations (Fig. 3). At a 6 weeks follow-up visit in our outpatient clinic, he reported no residual pain or dyspnoea. He had resumed all former activities, including heavy work in his horse stables. A chest X-ray at this stage showed abundant callous formation with progressive healing of all fractures.

4. Discussion

Since the advent of “internal pneumatic stabilisation” in the mid 1950s, the focus lay on the non-operative support of chest
trauma. Current EAST guidelines still recommend a non-invasive strategy with selective intubation and ventilation, analgesia, fluid administration and vigorous pulmonary hygiene. Nevertheless, this treatment modality remains associated with significant morbidity and mortality figures. These findings have inspired many surgeons during the last five decades to develop operative treatment alternatives with varying degrees of success. Reported techniques have evolved from percutaneous traction and suspension procedures towards open reduction and internal fixation (ORIF) of fractured ribs.

Nowadays, a renewed interest in chest-wall fixation has risen in the surgical communities throughout the world. This can be explained due to the publication of numerous promising clinical results on one hand, and the availability of newly specialised equipment on the other hand.

The beneficial effects of surgical stabilisation were already proven in a historical 2002 trial. Tanaka et al. randomised 37 mechanically ventilated flail chest patients to surgical stabilisation or nonoperative treatment. They found that operative fixation led to significantly less mechanical ventilatory support, lower incidence of pneumonia, shorter ICU stay, greater vital lung capacity, higher return to work percentage and reduced medical costs.

Granetzny and his colleagues published a prospective randomised trial comparing surgical wire fixation with mechanical ventilation and adhesive stripping of flail segments. They demonstrated a smoother postoperative course with significantly shorter ICU and hospital stay in the operative group. Patients surgically stabilised also had a significantly decreased rate of complications as compared to the conservatively managed patients. They developed almost no residual chest wall deformity with its resulting restrictive impairment on pulmonary function. Other nonrandomised, comparative studies have generally confirmed these findings in selected groups of flail chest patients.

Most of the former studies were carried out using older fixation materials such as intramedullary Kirschner wires, stainless steel cerclage wires or conventional plates and screws. The complexity and moreover the reliability of these techniques remain an important threshold limiting their utilisation. In our opinion the above-described technique using a combination of titanium plates, screws and intramedullary splints is superior to the traditional ones. The anatomic plate set can greatly simplify the procedure by minimising the need for perioperative plate contouring. The angular stability prevents well-known complications such as cut-out and plate migration. Rib splints prove a valuable alternative in those places where surgical access is limited. These clinical findings are strengthened by biomechanical evaluation of these implant systems.

In the trauma literature the decision to perform rib stabilisation is often based on individual patient characteristics, trauma mechanism, surgical rationale and local experience. The exact indications for operative rib fixation remain controversial. Potential considerations include flail chests, symptomatic non-unions of rib fractures, chronic pain, anticipated permanent loss of functional lung volume, severe chest wall deformities and chest wall reconstructions in the setting of open chest injuries.

In this specific case there was an obvious chest-wall deformity with substantial risk of further flail displacement and non-union of rib fractures. The related risk of future impaired respiratory function and chronic chest pain significantly affected the decision to operate on our patient. The main surgical goal was thus to restore chest wall stability and prevent long-term complications.

5. Conclusion

The aim of this manuscript was to report on a broader application of operative rib fixation in severe chest trauma. We presented the case of a more complex bilateral flail chest fixation with excellent postoperative results. Further prospective randomised trials are necessary to identify the specific indications for these types of procedures. In the meantime a selective and patient-tailored approach is advised.

References