CASE REPORT

Rib fracture fixation as a tool for extubation in a resource-poor environment

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Accepted 10 January 2019

SUMMARY

An elderly female with multiple comorbidities was involved in a pedestrian vehicle accident and sustained blunt chest trauma, arriving at a resource-poor hospital in rural South Africa. She had multiple bilateral rib fractures with a unilateral flail segment that caused her to develop respiratory failure. She was intubated and sent to the intensive care unit (ICU) for ventilation. She developed hospital and ventilator acquired pneumonia. She subsequently had hypoxic arrests on two separate occasions and two failed extubations. Despite inadequate access to provisions, this patient was taken to theatre for rib fracture fixation as an attempt to improve her lung function and get her off the ventilator. She was extubated two days after the procedure and discharged from ICU 4 days thereafter. On her follow-up, she reported that she had returned to normal daily living and tasks.

pain and decreased length of ICU and hospital stay and decreased complications.^{2–4}

CASE PRESENTATION

A 62-year-old non-smoking woman, a known hypertensive and diabetic on tablet treatment with a body mass index of 33, was involved in a pedestrian-vehicle accident. She sustained bilateral pneumothoraces, right-sided rib fractures 3–8 and left-sided 4 to 8 flail segment. Surgical chest drains (size 28G) were inserted bilaterally. She also sustained a mild traumatic brain injury with an admitting Glasgow Coma Score of 14/15, that did not require neurosurgical intervention. To control her pain, we used the WHO pain ladder. She was started on paracetamol 1 g four times daily orally, tramadol 100 mg three times daily orally and morphine 10 mg four times daily intravenously. The anaesthetic department was consulted and performed paravertebral and rib blocks with bupivacaine 2 mg/kg 8 hourly.

The patient was observed closely in a high care unit on admission (8 hours post injury). For the first 24 hours of admission the patient had a persistent tachycardia of 115–130 beats/min. She was normotensive and normothermic. Her saturation remained above 94% on face mask oxygen at 40% and her respiratory rate was within normal ranges. She continuously complained about pain and difficulty in breathing.

A Critical Care Consultant saw the patient 30 hours post admission, with a view to taking the patient to the ICU for ventilation. This was because the patient became tachypnoeic (from 21 to 37 breaths/min), oxygen saturations dropped from 96% to 90% on 60% oxygen via a Venturi mask, while using her accessory muscles of respiration. At this point, her arterial blood gas showed retained pCO₂ of 8.3 kPa and pO₂ of 7.6 kPa on face mask oxygen of 60%; type two respiratory failure.

The patient was intubated 36 hours after admission and transferred to ICU. This was the start of a 25 day stay in ICU. Day 1 post ICU admission, the patient had multiple secretions that required suctioning and a deteriorating lung compliance. She had crackles bibasally and CXR showed infiltrates with perihilar lymph node enlargement. She had a tachycardia of 134, temperature of 38.5°C, white cell count of 17.56 × 10⁹/L and C-reactive protein (CRP) 234. She was started on Ceftriaxone with the diagnosis of a lobar pneumonia. A sputum culture later grew *Streptococcus pneumoniae* with

BACKGROUND

The way rib fractures are managed in the trauma setting has changed markedly over the last 10 years. There is considerable morbidity associated with rib fractures, particularly in elderly patients or patients with comorbidities. Literature exists regarding blunt chest trauma with resultant rib fractures, flail segments and pain related to these injuries. The Eastern Association for the Surgery of Trauma guidelines recommend open reduction and internal fixation for the management of flail segments.¹

Patients with flail segments are suggested to need a high care environment for pain management and may even require intubation. With this type of blunt chest trauma, if patients are intubated then risks are ventilator associated infections, the need for tracheostomy for prolonged ventilation with a long intensive care unit (ICU) stay.

Rib fracture fixation (RFF) is available in some trauma hospital units, but it is not offered universally. We present a case at a district hospital, in rural KwaZulu-Natal in South Africa, of a patient who sustained blunt abdominal trauma following a motor vehicle accident who sustained multiple rib fractures with a flail segment who could not be extubated. The patient had RFF of the flail segment and was extubated 2 days later. These injuries, traditionally treated non-operatively, are now recommended to be surgically treated with RFF which may lead to better short term outcomes, decreased

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To cite: Dickson-Lowe RA, Buitendag JJP, Jolayemi OO, et al. *BMJ Case Rep* 2019;**12**:e227518. doi:10.1136/bcr-2018-227518

Figure 1 Three-dimensional CT reconstruction of the chest showing injuries of blunt chest trauma.

a sensitivity towards this drug and a course was completed. She had two failed extubations during her ICU stay (days 5 and 9), then had a tracheostomy placed in theatre on day 11.

On day 13 post admission, the patient had a leucocytosis on full blood count of 18.22 and a CRP of 176, suggesting ongoing infection. A further sputum sample grew *Klebsiella pneumoniae* suggesting a Ventilator-associated pneumonia (VAP), which was sensitive to Imipenem.

Day 16 saw another failed extubation and she had an hypoxic arrest requiring cardiopulmonary resuscitation. Following this event and reintubation, it was decided that RFF would be undertaken. On day 20, she was taken to theatre for this.

INVESTIGATIONS

Chest radiograph: Left anterior and posterior rib 4–8 fractures present with flail segments. Left posterior rib 2 and 3 fractures also present. Left posterior rib fractures present from 2 to 8. Bilateral pneumothoraces seen.

CT chest, abdomen, pelvis, brain and spine (pan-CT). In addition to the above rib fractures, there was a small left pleural effusion and right basal atelectasis (figure 1). There was also bilateral pulmonary contusion with a soft tissue component of the lateral chest and abdominal walls. The CT abdomen/pelvis was clear and the CT brain and C spine showed no intracranial lesions or spine abnormalities.

Chest radiograph (figure 2) showing RFF for the left flail segment.

DIFFERENTIAL DIAGNOSIS

Differential diagnoses preventing extubation: Impaired clearance of secretions, mucous plugging, ongoing chest infection, poorly compliant lungs, lung contusions.

Figure 2 Chest radiograph after rib fracture fixation.

Contributing factors: Continuous sedation, prolonged time spent on the ventilator, elderly/frail, neurological impairment, fluid overload, acute kidney injury.

TREATMENT

Analgesia for pain, antibiotics for lung infections and ventilation requirements have been described above. RFF was the only other intervention that this patient underwent on day 20 post admission. This was the first time in this hospital that rib fixation has been done. A team of two specialists, a trauma surgeon that trained in Sweden to perform this procedure, and a general surgeon specialist with two senior medical officers were involved in this procedure.

OUTCOME AND FOLLOW-UP

The patient was extubated 2 days after RFF and discharged to a high care unit on a general female ward. She received physiotherapy and rehabilitation in the ward and was discharged from hospital 5 days later. She was also provided with psychological support following her prolonged stay in ICU. The skin clips were removed 2 days post discharge at her local healthcare facility. The patient followed up at our outpatient department 1 month later with a healed wound, clear chest and clean chest film.

DISCUSSION

A flail chest occurs when there is a segment of the thorax that is separated from the rest of the thoracic cage. This is usually defined as at least two fractures in a rib for two or more consecutive ribs. This segment will hence not be involved in adequate lung expansion or gaseous exchange. The significance of flail chest, however is the presence of the underlying pulmonary contusion. In treating these injuries one should not only consider the fractures but the contusion as well.

These injuries lead to immense pain and an inadequate cough mechanism. This leads to secretion retention and atelectasis. This leads to a V/Q mismatch and increase work of breathing. This combined with respiratory muscle weakness will lead to muscle fatigue and respiratory failure that will require mechanical ventilation.^{4 5}

Blunt chest trauma with multiple rib fractures can be debilitating and cause chronic pain. It was traditionally thought to treat all these injuries non-operatively with adequate pain management and mechanical ventilation. Most trauma surgeons still apply these principles to their daily practice, particularly in resource-poor environments and even in departments where this skill is not available or yet routine practice. The non-operative treatment for these injuries include face mask oxygen with a pulmonary toilet. One can consider using Continuous Positive Airway Pressure masks to prevent intubation. Physiotherapy should be a cornerstone of all blunt chest trauma treatment. These injuries follow a path of prolonged hospital stay, time on the ventilator, pneumonias, time in ICU and post discharge disability and chronic pain. In this patient's case she was intubated timely and received all the possible analgesic modalities available at the hospital. Her rib fracture score was more than 15 and she required emergent care.^{4 5}

From a pain management perspective she received intra-pleural and intercostal analgesia. Although thoracic epidural analgesia may have been more effective in this instance it was not offered. The respiratory management that the patient received involved high frequency jet insufflation and nitric oxide. The hospital does not have extra-corporeal membrane oxygenation. Oscillation therapy is not available at this facility. The Battle score determines complication rates from rib fractures. Risk factors are age, number of rib fractures, chronic lung disease, anticoagulant use and oxygen saturation levels. This patient scored 41. With a Battle score of 31+ one can expect a probability of complications in excess of 88% with a SD of seven.⁶⁻⁸

All the available treatment modalities were given and her physiological deficits corrected, but she still was not able to be extubated. Since RFF had not been done at this institution before it took some time to make the necessary arrangements. The procedure is still a relatively new concept in South Africa and is only being performed in selected centres in the country.

In recent years studies have shown that RFF of these injuries improve the outcome and life quality of these patients. The indications for RFF includes persistent pain, severe chest wall instability, decline in pulmonary function testing, to wean off ventilator, shorten ICU time and hospital stay, cost reduction however studies need to be conducted to appreciate and define indications, timing and follow-up for quality of life in patients who receive RFF.^{2 3}

In a study that was done in South Africa, rib plating showed an improved outcome post rib fixation. There was a decrease in infection, Hospital and ICU stay and better post discharge pain control.⁸

In a resource restrained environment, like this hospital in KwaZulu-Natal in South Africa, treating injuries such as this can be a challenge. In rural and austere environments, we must use initiative and pull together the resources we have to get patients through these devastating injuries. It is often that we as doctors and surgeons attain novel ways of making patients better, from these situations. Given the success of this patient's journey following RFF, we will certainly be considering this for all of our patients with similar blunt chest trauma who present to our institution.

Patient's perspective

'After the accident I was in extreme amount of pain. The analgesia the doctors gave me help to an extent but could not give me adequate relieve. I was struggling to breath and it became harder with every breath. I do not remember much after they intubated me. I do remember waking up after the operation, able to breath well. I did not feel like I was breathing against myself. They removed the tube and I recovered rapidly. I could see my family and enjoy their company. After I was discharged from hospital I went back doing chores at home and I can even dance with my family at gatherings now.'

Learning points

- Rib fractures and flail segments require a high care environment with repeated re-assessment for deterioration.
- Analgesia should be the centre of management for all patients with blunt chest trauma.
- Rib fracture fixation should be considered for patients presenting with rib fractures and flail segments who end up in intensive care units, even in hospitals that are resource-poor.

Contributors JJPB and RAD-L wrote the article together including the case history and the literature search. RAD-L attained the images with 3D reconstruction. Both OOJ and GO were involved in the management of the case, operation and the overseeing of writing of the report. All authors made significant contribution to the writing of the case report.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

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