Management of rib fractures

ABSTRACT

Rib fractures are a common reason for hospital admission and are associated with significant morbidity and mortality. This article discusses the management of simple rib fractures and provides practical guidance for junior doctors involved in the care of these patients. Careful assessment to identify patients at high risk of complications is essential and calculation of a rib fracture score can aid management decisions. Pain from rib fractures can be severe and requires multimodal analgesia started promptly and proactively on hospital admission. This may include the use of regional anaesthetic techniques such as thoracic epidurals and erector spinae blocks for patients with significant chest trauma or those at high risk of pulmonary complications.

Rib fractures are a common reason for hospital admission and are associated with significant morbidity and mortality. This is caused by three main mechanisms:

1. Hypoventilation as a result of pain (resulting in an ineffective cough, sputum retention and atelectasis)
2. Impaired gas exchange in damaged lung (caused by pulmonary contusion and haemorrhage)
3. Altered breathing mechanics (especially where there is a flail segment present).

Patients with chest injuries have significant risk of deteriorating 48–72 hours after the event, because of the mechanisms described above and the subsequent development of respiratory failure. The incidence of pneumonia may be as high as 31% in the elderly (Brasel et al, 2006; Bulger et al, 2008). Mortality following rib fractures is reported as between 4 and 12% (Ziegler and Agarwal, 1994; Brasel et al, 2006) and may be as high as 33% in patients admitted to intensive care as a result of their injuries (Pressley et al, 2012).

Pain from rib fractures can be severe and difficult to manage, but effective multimodal analgesia started promptly and proactively on hospital admission enables deep breathing, coughing and clearance of secretions. This reduces secondary pulmonary complications. This article discusses the management of simple rib fractures and provides practical guidance for junior doctors assessing these patients and prescribing analgesia.

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Initial assessment

If appropriate, the patient should be initially assessed and managed by a multidisciplinary trauma team. Assessment should include a full history and examination. The presence and severity of comorbidities has important implications for the risk of developing complications. In particular, smoking-related or other chronic respiratory disease significantly increases the likelihood of complications and should prompt early escalation to higher levels of care and acute pain teams. Other risk factors which should prompt early discussion are listed in *Table 1*. Patients with complex analgesic needs such as those with renal or hepatic failure and patients with pre-existing chronic pain may also benefit from discussion with the pain team.

Examination should focus on identifying any signs of respiratory compromise such as hypoxia, inability to clear secretions, shallow breathing or paradoxical chest wall movements. Look for evidence of complications such as haemothorax, pneumothorax or pulmonary contusion. It is important to establish the location and number of rib fractures as this is one of the most important determinants of morbidity and mortality (Easter, 2001; Flagel et al, 2005). Of particular note:

- Multiple rib fractures are commonly associated with underlying pulmonary contusions
- Fractures of the lower ribs (7–12) may be associated with upper abdominal injuries
- A first rib fracture indicates a high energy impact and other (severe) injuries should be anticipated
- Flail chest occurs when two or more adjacent ribs are fractured in more than two places. This creates a 'floating' segment

Table 1. High-risk features which increase the risk of developing complications

Age >60 years
Existing chronic respiratory disease, including smokers
Frail or significant comorbidities
Hypoxia or any oxygen requirement
Pre-injury anticoagulation
Flail segment, pulmonary contusion, pneumothorax or haemothorax
Major trauma, especially head, pelvic, musculoskeletal or abdominal injuries
Any clinical signs of lower respiratory tract infection

of the chest wall which is unable to contribute to lung expansion. Paradoxical movements are often observed, as well as other signs of chest injury such as crepitus, tenderness, bruising and reduced chest expansion on the affected side. Intubation and ventilation is often required for these patients so they should be referred to intensive care.

Calculating a chest injury score (*Figure 1* and *Case study*) is a useful method of identifying patients who are at particular risk of deterioration and complications. (Easter, 2001; Holcomb et al, 2003; Battle et al, 2014). In the authors' hospital a score of 20 or more mandates critical care review. The benefits of critical care admission include higher levels of monitoring and earlier detection of deterioration, timely administration of analgesia, administration of certain medications not readily available on the wards (e.g. ketamine and fentanyl), and use of thoracic epidurals.

Baseline levels of pain should be assessed but it is more important to establish levels of pain on movement, deep breathing and coughing than at rest. An easy method of quantifying this pain is by using a simple dynamic pain score where patients are asked to describe their pain as none (0), mild (1), moderate (2) or severe (3) during coughing and deep breathing.

Figure 1. Calculation and use of the Chest Injury Score. Adapted from Battle et al (2014).

Chest injury score	
Age	+1 for each 10 years over the age of 10
Ribs fractured	+3 for each individual fracture
Chronic lung disease	+5 if present
Anticoagulant or antiplatelet use	+4 (exclude aspirin 75 mg)
Oxygen saturation on air (see ambulance chart)	+2 for each 5% decrease below 95%

Chest injury score with suggested treatment approach	
0–10	Conservative, e.g. simple analgesia, consider discharge home
11–20	Progressive, e.g. patient-controlled analgesia or regional anaesthesia
21–30	Aggressive, e.g. regional anaesthesia, consider high dependency unit admission +/- respiratory support (non-invasive)
>31	Emergent, e.g. consider intensive care unit admission – may require invasive ventilation

For example: 73-year-old, 4 x rib fractures, chronic obstructive pulmonary disease, oxygen saturations 96% on air
Score: 6 + 12 + 5 + 0 + 0 = 23 (for 'aggressive' treatment pathway)

CASE STUDY

Mr A is a 78-year-old man who was admitted via the emergency department having fallen from standing height onto his right hand side. The area where he fell was tender but his chest X-ray appeared normal. He was a smoker with a background of chronic obstructive pulmonary disease and was on warfarin for atrial fibrillation. On the day of his admission he was admitted to a trauma and orthopaedic ward. He looked well and was able to breathe and cough comfortably. Overnight he complained of more pain and his oxygen saturations fell. He was reviewed by the trauma and orthopaedic junior doctor who prescribed oral morphine and oxygen, but by the morning he was drowsy and his oxygen requirements had increased further.

After the trauma and orthopaedic team called for help, the intensive care, anaesthetic and pain team reviewed Mr A. He underwent a computed tomography scan of his thorax which demonstrated fractures of his 4–7th ribs on the right side. There was underlying pulmonary contusion and possible consolidation. He was moved to the high dependency unit where an erector spinae block and catheter was inserted by the anaesthetist. His pain significantly improved, he was more alert and he only now required minimal opiates. He was able to tolerate physiotherapy as he was much more comfortable.

Over the next few days his oxygen requirements reduced and he was discharged back to the ward where he was lined up for discharge home with a package of care.

Of note, Mr A's chest injury score was 27 on admission. This suggests he would have benefited from a more aggressive treatment approach, including prompt referral to critical care.

Imaging

As a minimum, all patients admitted to hospital with suspected rib fractures should have a chest X-ray. Plain films alone may vastly underestimate pathology in chest injuries. In fact, Murphy et al (2017) reported that >60% of rib fractures are not apparent on chest X-ray. Pulmonary contusions are often underestimated on chest X-ray at the time of admission.

For the above reasons, the National Institute for Health and Care Excellence (2016) advises early and liberal use of computed tomography chest imaging in patients with suspected chest trauma, particularly in the presence of multiple comorbidities or anticoagulation. Consider scanning other anatomical regions at the same time if other injuries are suspected. Remember that chest wall injuries can be very painful and can mask associated injuries.

For patients who are deemed appropriate and safe for discharge home, information should be provided, ideally as an information leaflet. It should explain:

- The importance of breathing exercises, coughing and mobilizing
- How to take regular analgesia to allow deep breathing
- When and where to seek help, especially if experiencing dyspnoea, producing phlegm, if fevers develop or if pain is inadequately controlled
- The likely time course of recovery, which may take up to 4–6 weeks to improve.

Analgesia

Providing prompt and effective analgesia is fundamental to the management of patients with rib fractures. A multimodal and stepwise approach should be adopted.

CURRICULUM CHECKLIST

This article addresses the following competencies from the Royal College of Anaesthesia for basic level (Core) training in Anaesthesia:

- Assesses and provides initial management of the trauma patient (I1_BK_03)
- Explains the importance of correct pain relief in the trauma patient and methods used (MT_BK_09)
- Demonstrates the ability to manage severe unrelieved acute pain and distress in a timely, safe and effective manner (PM_BS_05)

And the following Capabilities in Practice from the Joint Royal Colleges of Physicians Training Board Internal Medicine training curriculum:

- Managing medical problems in patients in other specialties and special cases
- Delivering effective resuscitation and managing the acutely deteriorating patient.

Non-pharmacological

- Use of a pillow to brace against the chest wall during coughing may be useful
- Humidified oxygen and regular nebulised 0.9% saline may help to loosen and clear secretions
- Chest physiotherapy is vital but requires adequate analgesia to be effective.

Pharmacological

Analgesia should be prescribed with consideration of the patient's comorbidities and possible drug side effects. Initially aim to gain rapid pain relief with titrated doses of opioids, e.g. intravenous morphine 0.1–0.2 mg/kg. Oxycodone is a good alternative in patients intolerant to morphine or with impaired renal function. Intravenous ketamine may be a useful adjunct or alternative to opioids but should only be prescribed by those experienced in its use and should be avoided in the elderly and those with altered cognition.

Once adequate pain relief is achieved, regular simple analgesia including paracetamol, a non-steroidal anti-inflammatory drug, if not contraindicated, and a weak opioid such as codeine phosphate or tramadol should be prescribed. For breakthrough pain, as required oral morphine or immediate release oxycodone should be given as necessary. If pain is poorly controlled, consider gabapentin. A starting dose of 100 mg three times a day is suitable for most patients but may be poorly tolerated with nausea, dizziness or sedation. Gabapentin should be avoided in those with renal impairment and the elderly.

If a patient is requiring frequent opioid doses then intravenous patient-controlled analgesia should be considered.

Topical lidocaine patches are sometimes used as an adjuvant therapy for complex patients but despite the appealing side-effect profile and anecdotal reports of successful analgesic effect, there is little evidence that they improve pain or reduce opioid use in patients with traumatic rib fractures (Williams and Carlton, 2015).

Regional anaesthesia

Regional anaesthetic techniques are an effective way of providing analgesia for patients whose pain is uncontrolled by systemic analgesia. Thoracic epidurals improve pulmonary function tests, reduce respiratory complications and decrease length of hospital stay (Yeh et al, 2012). Either a one-off 'single shot' technique can be used or more commonly a catheter is left in situ which is attached to either a continuous infusion or intermittent boluses of local anaesthetic.

Traditionally thoracic epidurals have been the technique of choice and these have a proven evidence base. More recently, alternative techniques including paravertebral, erector spinae and serratus anterior plane blocks have gained popularity. These have less effect on haemodynamics, have fewer associated risks and require less expertise to manage on the wards. However, because these are relatively new their evidence base is lacking, and predominantly they have only been discussed in case reports or series (Kunhabdulla et al, 2014; Hamilton and Manickam, 2017).

In the authors' hospital erector spinae blocks are favoured. Local anaesthetic is injected deep to the erector spinae muscle. This is in close proximity to the dorsal and ventral rami of the thoracic spinal nerve. It is thought that spread of local anaesthetic both caudate and cephalad is facilitated by the thoracolumbar fascia leading to extensive sensory block over the hemithorax (Hamilton and Manickam, 2017). Erector spinae blocks are suitable for all rib fractures and have few absolute contraindications. These include patient refusal, allergy to local anaesthetic and infection at the site of entry. For patients with sternal fractures a sternal catheter is sometimes placed but an erector spinae block is a suitable alternative.

Managing patients with local anaesthetic infiltration catheters on the wards

All patients with regional anaesthetic catheters in situ should be under regular review by acute pain specialists and be cared for by appropriately trained nursing staff. Pain should be assessed regularly using a dynamic scoring system. It is essential that patients are able to cough and take deep breaths. If analgesia is insufficient despite a regional block, then the acute pain team or duty anaesthetist should be contacted to review the dosing of local anaesthetic infusion and consider a bolus. It is safe to use concurrent oral or intravenous analgesics, but regional techniques aim to reduce the need for opioids and they should be weaned as soon as possible. Furthermore, regional techniques may remove a painful stimulus, resulting in apnoea from unopposed pre-administered opiates. A Royal College of Emergency Medicine (2018) safety alert highlighted this and the importance of regular observations after regional anaesthetic techniques.

A rare but life-threatening complication of regional anaesthesia is local anaesthetic toxicity. Local anaesthetic reaches the circulation via accidental intravenous injection resulting in a rapid onset of symptoms or by systemic absorption which typically leads to a delayed onset. The presenting features of local anaesthetic toxicity vary, but involve the cardiovascular and neurological systems. Early features include perioral tingling, tinnitus, slurred speech, hypertension and tachycardia. Later signs include confusion, depressed conscious level, hypotension and a variety of arrhythmias such as sinus bradycardia, conduction blocks, ventricular tachyarrhythmias and asystole (Christie et al, 2015).

If there is concern about local anaesthetic toxicity, then stop the injection of local anaesthetic, initiate resuscitation according to advanced life support principles and seek expert help. In the presence of circulatory arrest intravenous lipid emulsion rescue should be used (Association of Anaesthetists of Great Britain and Ireland, 2010).

Surgical fixation

Management of rib fractures by surgical fixation is thought to be beneficial for certain groups of patients. This includes patients with a flail chest and respiratory failure who require invasive ventilation, or non-intubated patients with a flail chest and deteriorating pulmonary function (Hasenboehler et al, 2011). The aim is to stabilize the chest to restore pulmonary mechanics and reduce pain. Other potential indications include pain refractory to analgesia, rib fracture non-union, and during a thoracotomy performed primarily for other injuries (Nirula et al, 2009).

Conclusions

Rib fractures carry high morbidity and mortality rates. They can be difficult to diagnose and concurrent injuries need to be considered. This article has outlined the management of rib fractures and highlighted certain patients at particular risk of deterioration. Proactive and effective analgesia, including regional anaesthetic techniques, is essential to avoid pulmonary complications with consideration of surgical fixation in certain circumstances. **BJHM**

Conflict of interest: none.

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KEY POINTS

- Rib fractures following chest trauma are common and are associated with significant morbidity and mortality.
- Increasing age and number of fractures are the most important determinants of morbidity and mortality.
- Pain from rib fractures can be severe and very difficult to manage but effective multimodal analgesia started promptly and proactively on hospital admission will enable deep breathing, coughing and clearance of secretions. This will ultimately reduce secondary pulmonary complications such as atelectasis, pneumonia and respiratory failure.
- Erector spinae catheters and thoracic epidurals are regional techniques which can be inserted by anaesthetists and can be used to help manage pain in rib fractures.

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