An audit of the management of 250 patients with chest trauma in a regional thoracic surgical centre

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SUMMARY

Two hundred and fifty patients with chest trauma admitted consecutively over a 6-year period to the Royal Surrey County Hospital were reviewed. This is a large series by British standards. The cause and nature of their chest and associated injuries were studied, together with the management, complications and outcome. The aim of this study was to find areas where diagnosis and treatment could be improved.

It was found that where there was no lung contusion, flail chest injuries could be managed without ventilation. The review suggests that even small traumatically induced pneumothoraces should be drained. It illustrates the need for an awareness of the wide range of concurrent problems in patients with chest injuries and the variety of possible complications.

INTRODUCTION

This study was undertaken as an audit of the Regional Thoracic Centre's performance in managing chest trauma. Patients were included in the study if they had one of the following signs: rib fractures seen radiographically, radiographic signs of lung or mediastinal injury, clinical evidence of respiratory impairment, or blood gas abnormalities. All but six patients were admitted via casualty; delay in the transfer of these six patients from other units was not associated with any morbidity.

Lung contusion was diagnosed where respiratory distress was associated with hypoxia as measured by blood gas analysis ($PO_2 < 6$ kPa). Although there were frequently radiographic changes (Figure 1), the policy of the unit was to regard X-ray changes alone as insufficient to make the diagnosis of lung contusion. A flail chest was diagnosed when three or more ribs had been fractured in two places (not infrequently at

Fig. 1 Contusion of left hemithorax.

the costochondral junction which cannot be demonstrated radiographically), producing an unstable segment which underwent paradoxical movement on respiration.

This unit followed a conservative policy in the management of patients with flail chest injuries, Trinkle *et al.* (1975), Shackford *et al.* (1976 & 1981), Richardson *et al.* (1982). Local anaesthesia in the form of intercostal nerve blocks, epidural infusions and, on occasion, intrathecal diamorphine were used to supplement systemic analgesia along with physiotherapy and oxygen (Worthley, 1985). Patients with flail chest injuries were ventilated only where there was evidence of lung contusion on blood gas analysis.

METHOD

The hospital records of 250 patients admitted consecutively over a 6-year period were studied retrospectively with special reference to the cause and nature of their injuries, their associated injuries, their investigations, complications, indications for thoracotomy, the management of flail chest injuries and outcome.

Nature of the injuries

A significant proportion of the series consists of patients with relatively minor injuries resulting from domestic or sporting accidents (Table 1). However, we had 61 patients with lung contusion, a flail chest or mediastinal injury and of these 14 (23%) died, this compares with other series, Dougall *et al.* (1977), Shin *et al.* (1979), Thompson *et al.* (1982). The patients' chest injuries are listed in Table 2 and associated injuries in Table 3.

Nine patients fractured their first rib, generally regarded as indicative of a severe injury (Richardson *et al.*, 1975). Of these, five had severe injuries to the mediastinum, two had spinal cord injuries, one had a tracheal tear and two had damaged subclavian vessels. Subclavian vessel damage was noted on arrival in one patient by the presence of a haematoma over the first rib and the absence of a radial pulse. An arch aortogram revealed an intimal tear of the subclavian artery (Figure 2), which was then repaired.

Table 1 Cause of thoracic injury

Road traffic accidents:	
Automobile occupants	110
Motorcyclists	32
Pedestrians	7
Cyclists	5
Miscellaneous (falls, sport, horse riding)	73
Industrial	10
Assault	9
No record	4

Table 2 Nature of chest injury*

Pneumothorax	46
Lung contusion	32
Flail chest	29
Haemothorax	21
Sternal fracture	28
Fractured first rib	9
Ruptured diaphragm	3
Ruptured subclavian vessel	2
Tracheal tear	1
Laryngeal tear	1
Ruptured bronchus	1
Mediastinal injuries**	7
Simple rib fractures	102

* Many patients had more than one type of injury.

** (1) Aortic tear distal to left subclavian artery.

(2) Ruptured right atrium.

(3) Ruptured left atrium and pericardium.

(4) Cardiac tamponade with torn inferior vena cava and ruptured mitral valve.

(5) Three patients with cardiac contusion.

Table 3 Associated injuries*

Orthopaedic injuries	50		
Head injuries	39		
Fractured spine	19	Cervical	5
		Thoracic	11
		Lumbar	3
Splenic injury	10		
Renal damage	10	Haematuria with normal I.V. Urogram	
	4	Contusion diagnosed by I.V. Urogram	
	1	Avulsion of renal artery	
Ruptured liver	7		
Small bowel perforation	4	(plus 2 with tears of the mesenteric vessels)	
Requiring exploratory laparotomy	26		
Multiple injuries	104		

* Many patients had more than one type of injury.

Fig. 2 An arch aortogram showing an intimal tear of the left subclavian artery.

The other patient with disrupted subclavian vessels arrived moribund and the diagnosis was made at post mortem.

Investigations

Six arch aortograms were undertaken, two for possible subclavian vessel damage suspected because of a haematoma associated with a first rib fracture. Four were done because of a widened mediastinum on chest X-ray: one revealed an aortic tear distal to the left subclavian artery which was repaired with a Dacron graft, another showed an intimal subclavian tear, and the rest were normal.

Creatinine phosphokinase (myocardial fraction) was measured in 25 patients, and was normal in all patients, even in the three who had suffered significant cardiac contusion. This may be explained by a report by Hamilton *et al.* (1984), where CPK-MB levels were found not to be raised until 2–4 days after injury, whereas in our patients most levels were checked within the first 48 h.

Ten intravenous urograms were performed for haematuria or suspected renal trauma. Four showed contusion which resolved without treatment. One patient had a non-functioning kidney and an arteriogram revealed avulsion of the renal artery; no treatment was undertaken and the patient is under review.

Indications for thoracotomy

Thoracotomy was undertaken in the following situations: massive or continuous intrapleural haemorrhage, cardiac tamponade despite pericardial aspiration, a widened mediastinum with a left haemothorax, damage to major vessels demonstrated by arteriography, a large pleural air leak suggesting a ruptured bronchus, or a ruptured diaphragm (Table 4). While a policy of 'internal pneumatic stabilisation' by ventilation was followed for flail chest injuries with lung contusion, two patients underwent

Table 4 Reasons for thoracotomy (22 patients)

Active intrapleural haemorrhage	10
Cardiac tamponade with torn inferior vena cava and ruptured mitral valve	1
Ruptured subclavian artery	1
Ruptured aorta	1
Ruptured pericardium and left atrium	1
Tracheal tear/ruptured bronchus	2
Ruptured diaphragm (See Figure 4)	3
Flail chest (large flail segment, undergoing a general anaesthetic for another procedure)	2
Retrieval of three Kirschner Nails previously inserted which had migrated into the chest	1

fixation of their flail segment within 36 h of their injury as both patients were undergoing surgery for other reasons. Three patients had their fractured sternum wired, one for gross deformity, two after 2 weeks because of continuing severe local pain.

Management of flail chest injuries

Sixteen of the 29 patients with a flail chest had lung contusion with an average PO_2 of 4.4 kPa in air. These patients sustained worse trauma and were ventilated until blood gas analysis indicated that lung parenchymal damage had resolved. Subsequent management was as for those with flail chest injuries without lung contusion. The presence of a flail segment did not in itself affect the decision to withdraw ventilation, and these patients were ventilated on average for 10.9 days. Complications following ventilation included two deep vein thromboses, two stress ulcers, one polyp associated with tracheostomy and one sacral sore. The 13 patients with flail chest but without lung contusion were managed without complication as described, except for one patient treated with intrathecal diamorphine who developed a chest infection and required ventilation after 6 days.

Complications

Forty-one patients in all developed chest infections with a pyrexia lasting for more than 36 h, and either purulent sputum production or physical signs. The factors associated with chest infections were the severity of the injury, smoking and mechanical ventila-

Fig. 3 A left haemothorax.

Fig. 4 A ruptured left diaphragm.

tion. Ninety-three per cent of those who developed chest infections were smokers as against 45% of those not affected. Chest infections occurred in 37% of ventilated patients as opposed to 13% of the remainder. No specific organisms were cultured.

Intercostal drains were inserted in 46 patients with pneumothoraces, 27 patients with haemothoraces (Figure 3) and five patients who had both. In eight of these patients an effusion developed more than 36 h after admission. Eleven patients had a small pneumothorax (less than 20% of the radiographic lung field) and were observed; however, five increased in size and later required the insertion of a chest drain. It is instructive to note that two intercostal drains were placed below the diaphragm in error as collapse or phrenic nerve damage had altered the diaphragm's position.

Non-thoracic complications of injury consisted of neurological problems (12 patients developed epilepsy or were unable to return to their original occupation following head injury), pressure sores (2), nerve root lesions (3), deep vein thrombosis (3), kyphosis (1), stress ulcers (2), and a dropped foot.

Fourteen patients died and the causes are listed in Table 5.

Table 5 Cause of death

Cause	Time after admission	Age (years)
Head injury (4)	3 days average	22, 30, 37, 82
Head injury, Le Fort II fracture, Ruptured left atrium and pericardium (cardio-respiratory failure)	36 h	70
Ruptured right atrium	40 min	50
Ruptured subclavian vessels	Moribund on arrival	20
Ruptured IVC and mitral valve cardiac tamponade (cardiac failure)	8 h	30
Head injury, pelvic fracture, flail chest (pulmonary embolus)	20 days	55
Haemothorax, ruptured liver, hemi-hepatectomy, (inferior vena cava thrombus)	4 days	24
Massive ruptured liver (unable to control bleeding)	6 h	53
Rib fractures, myocardial infarction	2 days	70
Cardiac failure (secondary to cardiac contusion)	4 days	74
Post thoracotomy (congestive cardiac failure)	20 days	81

DISCUSSION

Seat-belts

Seat-belts were worn by 44% of the 110 car occupants and there was no significant difference in the type or severity of injury between wearers and non-wearers, except that a high proportion (22/28) of patients with sternal fractures wore seat-belts. However, the benefit of wearing a seat-belt cannot be evaluated without knowledge of the nature of the collision (Newman, 1984).

Forty-one per cent of the patients in this series had other injuries in addition to their chest trauma. Of 14 deaths, six could be attributed to chest injury and were largely a consequence of cardiac damage.

The audit shows that patients with flail chest injuries and no lung contusion can be managed without ventilation using appropriate local analgesia, physiotherapy and oxygen. Ventilation was discontinued when blood gases showed no significant shunting and management was continued as for flail chest injuries without lung contusion. This resulted in a shorter period of ventilation which is considerably less than reported elsewhere, Trinkle *et al.* (1973), Dougall *et al.* (1977). This shorter period of ventilation may account for the fact we had few complications following ventilation in comparison with other series (Fleming *et al.*, 1972; Trinkle *et al.*, 1973; Shackford *et al.*, 1981; James & Moore, 1983) Nearly all those who developed chest infections were smokers.

Prophylactic antibiotics did not appear to prevent chest infections but the timing and choice of agents varied, thus limiting the conclusions which could be drawn.

Chest drains were used for the majority of patients with traumatic pneumothoraces; however, of the 11 patients with a small pneumothorax who were observed, five eventually required drainage and this corroborates the teaching that chest drains should be inserted for traumatic pneumothoraces however small. It is essential to site emergency chest drains above the nipple line as our experience demonstrates. Our findings confirm that fracture of the first rib is associated with severe injuries (Richardson *et al.*, 1975). An unusual injury which may become more frequent with seat-belt legislation is disruption of the subclavian vessels and this should be suspected if there is a first rib fracture and no radial pulse (Phillips *et al.*, 1981).

Severe concomitant injuries are extremely common and make a thorough initial examination of the patient essential.

Repeated re-assessment is necessary to detect the development of further complications.

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