Thorax 1984;**39**:789–793

Penetrating injuries of the pleural cavity

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ABSTRACT Two hundred and fifty one cases of penetrating wounds of the chest were studied prospectively. Clinical evidence is presented to show that: (1) basal intercostal drains are adequate to remove both air and fluid from within the pleural cavity; (2) frequent chest radiographs are unnecessary and intercostal drains may be removed on clinical grounds alone; (3) long term antibiotic prophylaxis is unnecessary; (4) eight per cent of those undergoing initial observation will develop a delayed haemothorax or pneumothorax of sufficient size to require drainage; (5) subcutaneous emphysema is of no prognostic significance in the symptomless patient with minimal intrapleural damage on admission; and (6) outpatient follow up is not required.

Intercostal tube drainage after penetrating chest trauma not affecting the heart or great vessels has been the standard method of treatment for many years at the King Edward VIII Hospital in Durban. Several questions concerning this approach, however, remain unanswered. The use of serial chest radiographs and long term antibiotics, the outcome in those undergoing simple observation, the importance of surgical emphysema in the symptomless patient, the need for outpatient follow up, and the optimum time for drain removal are all matters on which no set guidelines have emerged. This study discusses these problems and offers a standard protocol to be followed in cases of penetrating pleural injury.

Patients and methods

Two hundred and fifty one consecutive cases of penetrating injury of the pleural cavity were studied prospectively in a 10 month period from September 1982 to June 1983. Stabbing was the most common cause of chest injury, occurring in 247 (98%) cases. The remaining four cases resulted from low velocity gunshot wounds. All patients were admitted to one of the six surgical units in King Edward VIII Hospital, Durban. Patients were examined initially in the casualty department and after clinical assesssment had an inspiratory chest radiograph taken. In addition, at the time of initial assessment the presence or absence of the following was documented: (1) shock as defined by a systolic blood pressure of less than 100 mm Hg and a pulse rate greater than 100 beats/min; (2) multiple stab wounds; (3) severe associated head, limb or abdominal injury; (4) respiratory distress; (5) subcutaneous emphysema.

One dose of tetanus toxoid vaccine (Tetanus Vaccine BP, Wellcome) and 4 ml of bicillin (Brocades Great Britain Ltd) were administered intramuscularly at the time of admission. A decision on the need for drainage was made after the chest radiograph had been taken. All patients with fluid above the angle of the 7th rib or an apical pneumothorax greater than 2 cm on the inspiratory film were submitted to intercostal tube drainage. Patients not meeting these criteria were observed and the chest radiograph was repeated the following morning. Drainage was performed under local anaesthesia through the 5th intercostal space in the mid axillary line with a Malecot catheter in conjunction with a trocar and cannula. The drains were immediately connected to an underwater seal drainage system. Basal drainage was employed regardless of whether air or fluid was present in the pleural cavity.

Patients were thereafter assessed clinically, no further radiographs being taken before removal of the drain, which was performed when *(a)* there was no fluid drainage and *(b)* the drain was not swinging. The term swinging denotes an excursion of more than 6 cm of the fluid level in the underwater seal drainage system, indicating that the drain is still patent. Minor degrees of fluctuation represent movement of the thoracic cage and indicate that the drain is either blocked or has served its purpose.

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Accepted 26 April 1984

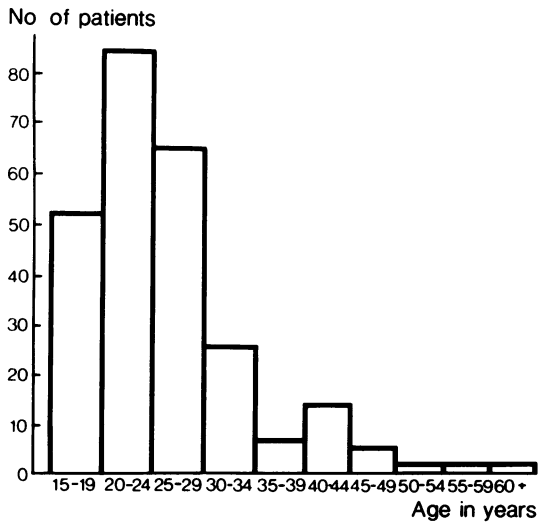

Fig 1 *Age distribution of 251 patients with penetrating chest injuries.*

Any pyrexia that developed during inpatient treatment was noted and after removal of the drain the tip was sent for bacteriological culture.

After removal of the drain all patients had a chest radiograph taken in inspiration. If fluid did not extend above the angle of the 7th rib and a pneumothorax of not more than 2 cm was present the patient was discharged and given an appointment for the surgical outpatient clinic within 14 days of discharge. All patients had a further chest radiograph at that attendance.

Results

Most stab wounds occurred in the left pleural cavity anteriorly (44%), which is consistent with assault by a right handed assailant. The remainder were distributed among the right chest anteriorly (28%), the right chest posteriorly (11%), and the left chest posteriorly (17%).

Assault occurred most commonly among young African men, the incidence declining rapidly with advancing age (fig 1). The male:female ratio was 7·6:1. Varying degrees of severity of injury were encountered, ranging from those with subcutaneous emphysema only to those with a massive haemopneumothorax. Out of the 251 patients three had bilateral injury, so that there were 254 injuries to the pleural cavities for consideration (fig 2). Of these, 169 (67%) required immediate drainage based on the above mentioned criteria. The remaining 85 (33%) underwent initial observation followed by a repeat chest radiograph the next morning. In seven (8%) of these patients this radiograph showed an increase in the amount of fluid or air sufficient to fulfil the criteria for intercostal drainage and delayed drainage was instituted.

The commonest condition encountered was haemopneumothorax, occurring in 114 (45%) of pleural cavities (fig 2); the second commonest was pneumothorax alone, which occurred in 92 (36%) cases, haemothorax alone occurring in 38 (15%). There were 10 (4%) pleural cavity injuries with subcutaneous emphysema alone and no intrapleural damage seen on the chest radiograph.

Figure 3 shows that, out of three possible conditions that resulted from pleural cavity injury, haemopneumothorax was the one most likely to require drainage. Of the 114 haemopneumothoraces, 95 (83%) were submitted to immediate intercostal drainage. Those patients with haemothorax or pneumothorax alone were distributed evenly between the drained and not drained groups. Of the seven patients with pleural cavities requiring delayed drainage, four (57%) had a haemopneumothorax.

GROUP WITH DRAINAGE

Combining those that required immediate drainage

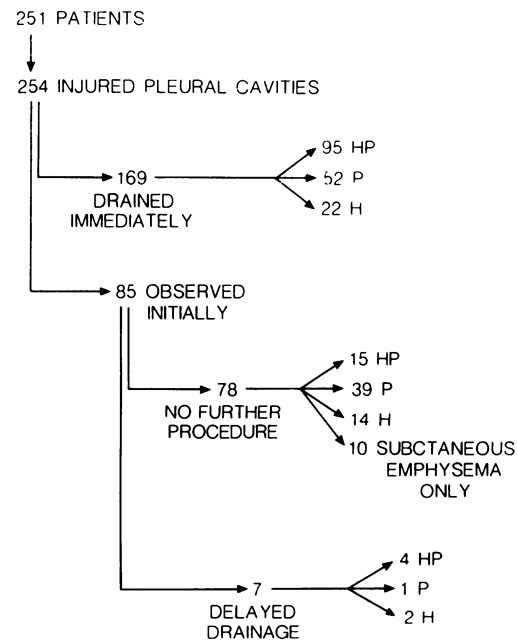

Fig 2 *Management and outcome in 254 penetrating injuries of the pleural cavity.*
HP—haemopneumothorax; P—pneumothorax alone; H—haemothorax alone.

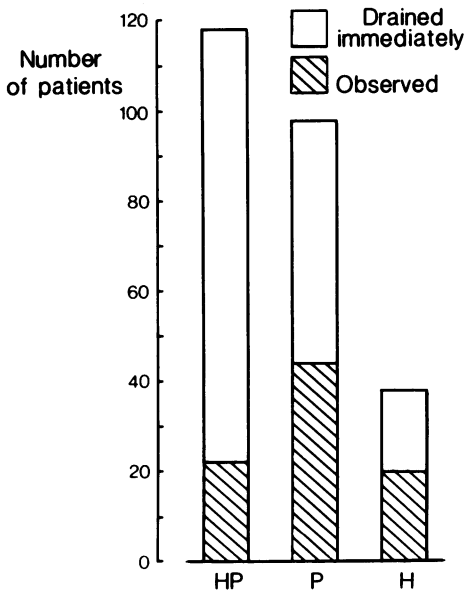

Fig 3 *Ratio of patients who had initial drainage to observed patients with regard to intrapleural complications. HP—haemopneumothorax; P—pneumothorax alone; H—haemothorax alone.*

with the seven requiring delayed drainage resulted in a total of 176 patients with drained pleural cavities. As indicated above, drains were removed on clinical grounds and the time drains were left in situ is illustrated in figure 4. Most drains (70%) were removed within 36 hours; 90% were removed within 48 hours and 97% within 72 hours. The remaining six drains were in situ for a longer period owing to a variety of factors—persistent bubbling, empyema, and in one case thoracotomy.

Empyema occurred in two patients, both arising from early blockage of the drain. Both were recognised on the chest radiograph after removal of the drain—a residual fluid collection being seen within the pleural cavity—and by the clinical condition of the patients, both of whom were febrile, toxic, and mildly dyspnoeic. One of these patients responded well to further intercostal drainage, with complete resolution. The second patient was referred to the thoracic unit and was managed conservatively with a satisfactory outcome.

Tension pneumothorax occurred in two patients and both improved dramatically after immediate drainage. One patient required thoracotomy for peristent bleeding after intercostal tube drainage. At thoracotomy a large lung laceration was sutured with a satisfactory result.

There was one death (0·6%) in the "drained" group. This patient had sustained a gunshot wound in the right lower chest 24 hours before admission. On examination he was paraplegic with obvious peritonitis and had a massive right haemothorax. Laparotomy revealed injury to the liver, right kidney, spine, and colon. The colonic injury was exteriorised but the patient succumbed to septicaemia six days later. A further six patients underwent laparotomy for suspected intra-abdominal injury. Three of these patients had separate abdominal wounds and penetration of the diaphragm was found in four out of the total of seven patients submitted to laparotomy. Although all these patients had been submitted to tube thoracostomy for chest injuries, only five fulfilled the criteria for drainage. The remaining two drains were inserted at the request of the anaesthetist as the patient was to undergo artificial ventilation and concern was expressed about the danger of a tension pneumothorax.

OBSERVED GROUP

Of the 85 pleural cavities not fulfilling the criteria for immediate drainage, seven (8%) required delayed drainage as a result of the radiographic findings on the morning after admission. There were no untoward sequelae following delayed drainage and the drainage times did not differ from those of the patients undergoing immediate drainage. There

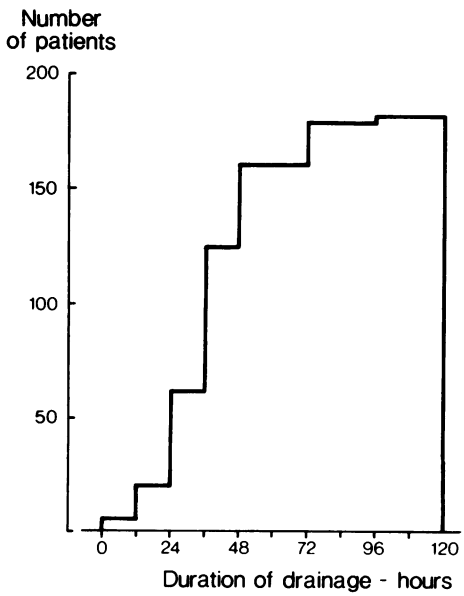

Fig 4 *Cumulative histogram showing duration of drainage in 176 patients with penetrating injuries of the pleural cavity.*

was no morbidity and no mortality in the group.

Multiple stab wounds were present in 30 (18%) of those drained initially and in 10 (12%) of those observed. Appreciable associated trauma was found in 21 (12%) of the drained group and in seven (8%) of the observed group. Thirty five (21%) patients fulfilling the criteria for drainage had respiratory distress, most (62%) suffering a haemopneumothorax. Shock, as defined in this study, was present in 14 (8%) of the drained group but was absent in the observed group. Subcutaneous emphysema was present in 35 (41%) patients not having initial drainage. Ten of these had no intrapleural lesion on the chest radiograph. Only one (1·1%) required delayed drainage after expansion of a small pneumothorax. Of those whose pleural cavities were drained initially, 21 (12·4%) had subcutaneous emphysema. Pyrexia greater than 37·5°C developed in 67 (40%) of those drained initially and in eight (9%) of those observed. Except in the two cases of empyema, culture of the drain tips revealed a mixed growth of non-pathogenic commensal organisms, mostly *Staphylococcus epidermidis* and *Bacillus* species. Most febrile patients had blood in the pleural cavity and this is assumed to have been responsible for the pyrexia. On discharge 58 (68%) of the observed group had minor residual signs of injury, whereas only 42 (25%) of those undergoing drainage had such signs.

As reported in other studies from our area, outpatient follow up is invariably poor and only 44% of patients attended for review in this series. Two patients required readmission for aspiration of a residual haemothorax. Both had undergone immediate drainage and both presented after the normal follow up time, their initial review having been satisfactory. The remainder seen in the outpatient clinic were all discharged, the repeat chest radiographs on the day of attendance showing either complete resolution or minor degrees of pneumothorax or haemothorax or both.

Discussion

The treatment of penetrating injuries of the chest has changed dramatically over the last 20 years, from an aggressive surgical approach to a more conservative policy using intercostal tube drainage.[1] Even this method of treatment is currently being challenged by those who advocate simple aspiration for an uncomplicated pneumothorax.[2] Although this method has proved satisfactory in iatrogenic pneumothorax, it has yet to be tested in violent injuries with more severe wounds of the lung.

Apical and basal intercostal drainage for air and fluid respectively in the pleural cavity has been the standard policy in the past, based on the physical properties of gas and liquid. But when present within a rigid cavity containing an expansile organ—namely, the lung—gas will follow the line of least resistance to escape compression. Fluid will drain by gravity alone. Basal drainage alone, as described in other studies,[3 4] is therefore adequate. There were no complications arising from this technique in this study. The practice of clamping the drain for 24 hours before removal is also unnecessary provided that adequate clinical assessment of the patient is undertaken.

Similarly, serial chest radiographs are not required if adequate clinical supervision of the patient is being carried out. It is, however, mandatory that the patient has a chest radiograph after removal of the intercostal drain and before his discharge from inpatient care. With this policy of maximal clinical and minimal radiological assessment care of the patient is ensured and hospital costs are reduced.

When intercostal drainage is necessary the commonest underlying condition is a haemopneumothorax, as indicated by other authors.[1 3] The combination of large amounts of blood and air in the pleural cavity reflects the severity of the trauma inflicted. This is confirmed by the finding of a greater proportion of multiple stab wounds in the drained group and a higher incidence of other important injuries to the patient.

Subcutaneous emphysema was present in 41% of patients in the observed group. Only one of these patients (2·8%) required subsequent drainage. In those patients who underwent immediate intercostal drainage emphysema was noted in only 12·4%. The presence of subcutaneous emphysema in combination with either a normal chest radiograph or minimal change is therefore of no prognostic significance in identifying those patients who are liable to develop a delayed pneumothorax. Indeed, although the numbers in each group are small, it may be inferred that the presence of air in the subcutaneous tissues rather than the pleural cavity carries a good prognosis, the potential pneumothorax having decompressed externally. It must be stressed, however, that this is true only of the symptomless patient. In the dyspnoeic, distressed patient progressive subcutaneous emphysema may indicate a developing tension pneumothorax.

Of those patients with minimal changes who underwent observation initially, 8% required delayed drainage. This compares favourably with other series.[3 5 6] All the patients in the observed group had a repeat chest radiograph within a maximum period of 24 hours. This would appear to be adequate for inpatient observation.[5 6]

Pyrexia lasting for 48 hours was a common finding in this series. Culture of both drain tips and sputum revealed no pathogenic organisms. The initial treatment of tetanus toxoid and bicillin is therefore adequate prophylaxis and long term antibiotic cover is unnecessary provided that daily physiotherapy is performed. Both patients who developed an empyema produced *Staphylococcus aureus* on culture of the chest aspirate, the organisms being resistant to penicillin but sensitive to cloxacillin.

Minor degrees of haemothorax and pneumothorax are of no importance and the symptomless patient may be discharged from inpatient care. The outpatient attendance in this series was less than 50% and is a reflection of the socioeconomic condition of the black population in Natal. If a patient is well then he resumes his occupation and the time taken to attend clinics results in decreased earnings and fear of unemployment. We therefore have to assume that most patients remain well after discharge from inpatient care. The interunit referral system in our hospital is such that any patient readmitted to the hospital is immediately referred to the original parent unit. Any complications after discharge are therefore reviewed by the unit which supervised the original care of the patient. There were no such readmissions in this study and we infer that the initial treatment was successful.

Although follow up attendance was poor, those who did attend for review within the normal follow up time suffered no complications. Minor residual signs present on discharge had resolved completely as demonstrated by the chest radiograph taken on the day of attendance at the review clinic. The two patients who required readmission for aspiration of a residual haemothorax both attended long after the normal follow up period. For these reasons routine outpatient review is deemed unnecessary, as long as the guidelines for inpatient care are followed and a chest radiograph is obtained before discharge of the patient.

The use of intercostal drains in the prophylaxis of pneumothorax in those patients undergoing artificial ventilation has been discussed in the context of other series.[3 6] We support the view of the authors of these papers that insertion of an intercostal drain in the symptomless patient should be a routine procedure as the development of an unrecognised tension pneumothorax in the anaesthetised patient may have a disastrous outcome.

Seven patients underwent laparotomy for suspected intra-abdominal injury. Four of these patients had sustained penetrating wounds of the diaphragm. These were all recognised by the presence of peritonism. Small penetrating wounds of the diaphragm causing no intra-abdominal damage, however, are extremely difficult to detect. These patients are at risk of developing delayed herniation through the defect months or even years later. Low chest wounds, especially on the left side, should be viewed with a high index of suspicion. Clear radiographs of both chest and abdomen should be obtained before discharge of the patient, and if any doubt exists contrast studies of the intestinal tract should be undertaken. Repair of the diaphragmatic defect at an early stage in its development is a much less formidable procedure than an attempt at repair once complications have arisen.

Only one patient underwent thoracotomy for persistent bleeding (0·3%). This compares favourably with the incidence in other series[1 3] and supports a conservative policy of tube thoracostomy in the treatment of penetrating chest trauma.

As mentioned earlier, aspiration of small amounts of air in the pleural cavity by means of a fine bore catheter has produced encouraging results. This is simply a modification of the Heimlich valve system that has been used in the outpatient management of both spontaneous and traumatic pneumothoraces.[7] This undoubtedly reduces hospital costs but should be used only in an environment where compliance can be expected from all patients. In the management of traumatic chest injuries where follow up is known to be poor tube thoracostomy should remain the preferred method of treatment.

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