Clinical Surgery

THORAX

CONSULTANT EDITOR

A. L. d'ABREU

CLINICAL SURGERY—5

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CLINICAL SURGERY

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PREFACE

There are several fine journals dealing with the current advances and excitements of thoracic and cardiovascular surgery; such journals rightly devote the major part of their space to serious investigational contributions. In the present nature of progress much that is published in thoracic and cardiac journals deals with the complexities of open cardiac surgery. In this volume of "Clinical Surgery" an attempt has been made to meet the needs and fulfil the curiosity of those whose medical interests are not confined predominantly to diseases of the thorax but who must have an acquaintance with those fields of thoracic surgery that have been cultivated so assiduously and successfully that they now occupy a large part of the whole realm of surgery. To achieve this object a "review" approach has of necessity been adopted, emphasis being placed on the presentation of what at the moment is regarded as accepted practice. The editor of this section is sustained by a company of co-operative colleagues versed in a deep knowledge of thoracic surgery and yet writing with a special interest in the subject which forms the material of their chapters. Most of the contributors know each other personally or through the contact of associations and societies devoted to general and thoracic surgery. In an attempt to cover the aims of this volume on the "Thorax" they have insufficient space in which to muse speculatively on future developments but have accepted the task of writing clearly about the present. The problems connected with everyday conditions such as cancer of the lung, diseases of the oesophagus, hiatus hernia and thoracic trauma have by no means reached final definition or solution; none the less, certain principles have been established which may stand the test of time. I hope the readers will find the expositions on the common surgical conditions of the thorax as clear and as instructive as I did. Throughout, an effort has been made to place more emphasis on the physiopathology of the disorders and their investigation by clinical and ancillary methods than on operative procedures, unless the writers have considered technical details essential as in the care of sudden physiological derangements calling for urgent mechanical correction, as by tracheostomy or the relief of sudden changes in intrapleural tensions. Careful attention has been paid to the "indications" for surgical treatment. An attempt to balance the common from the unusual has been made in the allocation of space—carcinoma of the lung must involve every medical man, but "chylothorax" may provide a solitary problem to few physicians in the course of a lifetime. Stress, however, has been placed on accounts devoted to conditions such as tracheo-oesophageal fistula—no longer a necessarily fatal condition but one which will escape early notice unless the condition has been pondered upon before the first patient is seen. We have attempted, however to achieve a comprehensive cover, without being too dogmatic or too compendious.

Birmingham
1964

A. L. d'ABREU

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CHAPTER 1

THORACIC TRAUMA

J. S. GLENNIE

Between 1951 and 1961 the number of registered road vehicles in Great Britain increased from 4,620,888 to 9,907,000. In 1951 there were 216,493 road accidents and 5,250 people died; in 1961 there were 349,767 accidents and 6,908 people died. Chest injury was either the direct cause or a major contributing factor in a quarter of the deaths, and many of the casualties died within a few hours of reaching a hospital casualty department.

A large number of deaths such as these could be prevented if the correct treatment were available and given immediately.

FIRST AID

All ambulance and first aid workers should have intensive training in the treatment of chest injuries. A "sucking wound" must be closed at once by a firmly anchored pad, preferably sterile, such as Vaseline gauze, but in the absence of anything better the palm of the hand will suffice. In a reported case, life was saved by the use of the patient's tie. Vomiting occurs very frequently after any severe chest injury, and is almost inevitable if there is associated head injury. The inhalation of gastric contents often produces fatal results and should be prevented. Dentures should be removed and the patient placed on his right side to allow regurgitating gastric contents to drain out of the mouth, and to prevent the tongue falling back into the pharynx and obstructing the airway. Only when there is paradoxical movement of the left side of the chest should the patient be placed on his left side in order to help control the unstable chest wall and improve respiration. Oxygen should be given if available and artificial respiration administered when the patient's own respiration is deemed to be inadequate. Mouth-to-mouth breathing or some other form of positive pressure respiration should be used. On no account should manual compression of the chest be done lest further damage be caused. These simple manoeuvres will save lives, but they can, and must, be carried out quickly, and should never delay the most expeditious transfer of the patient to hospital where trained medical personnel should be available immediately.

MANAGEMENT IN HOSPITAL

The conditions of respiratory and circulatory imbalance are akin to those which exist during major thoracic procedures and experience in pre-operative, operative and post-operative management of thoracic surgical cases is invaluable to personnel responsible for treating chest trauma. Under ideal

circumstances, therefore, all patients with severe chest injuries require surveillance by a thoracic surgical team, but it is unusual in Great Britain for such conditions to obtain. Barrett (1960), noting that the services of a thoracic surgeon are seldom asked for until the patient has survived for 48 hours, said: "Patients with multiple injuries, including a 'stove-in chest' often die without obvious cause. Haemorrhage has been stemmed, transfusions have been given to combat shock, and ample morphine has relieved the sharp edge of the pain. The sedated patient lies quietly in bed and his shallow paradoxical respiratory movements escape critical notice. But death steps in suddenly, peacefully, naturally—and unnecessarily."

The claim that the thoracic surgical services treat only a small proportion of chest injuries seems to be supported by the fact that to a major thoracic surgical unit in the North, serving an urban population of over 2 million, only 155 cases of civilian chest injuries were admitted between 1940 and 1960.

Personnel and Facilities

To deal with thoracic injuries the following personnel and facilities should be available.

(1) A team of specialists is required: (*a*) an anaesthetist, preferably experienced in managing the open chest and with a knowledge of respiratory and biochemical hazards and their remedies, to advise on and, when necessary, undertake intermittent positive pressure respiration; (*b*) a surgeon to advise on and undertake emergency thoracotomy when necessary and to supervise the treatment of shock; (*c*) a physician to assess cardiac damage, because trauma to the heart may closely simulate cardiac infarction, both clinically and electrocardiographically, and requires almost identical treatment.

(2) Trained medical assistants are required, because the constant presence of a doctor may be essential when resuscitation is prolonged.

(3) Trained nurses must be available.

(4) First-class radiography, which includes skilled radiographers and the services of a radiologist experienced in chest work, is invaluable. The apparatus, portable as well as departmental, must be of the highest quality.

(5) A 24-hour laboratory service is essential because biochemical tests may need frequent repetition and parenteral fluids may well be required.

TYPES OF WOUND

Penetrating Wounds

Penetrating wounds are common in war but, in Great Britain at least, are fortunately rare in peacetime, although the occasional stab or gun-shot wound, accidental or intentional, requires treatment.

Particularly destructive wounds have been seen after boating accidents in which the propellers of powered boats have sliced off part of the chest wall and even the underlying lung.

After the experience of treating the large number of casualties in World War II it became obvious that a patient with a serious chest injury requires, in the first instance, two things.

(1) The immediate restoration of effective pulmonary ventilation.

This demands provision of a free airway, by removal of blood or mucus or other foreign material from the trachea or bronchi. Expansion of the lungs must be ensured by emptying the pleural cavities of air or blood or both. An unstable chest wall must be stabilized. This done, the patient will have an efficiently moving chest wall, empty pleural cavities, patent bronchi and aerating lungs.

(2) Treatment of shock, which usually entails replacing lost blood. Penetrating wounds may not be confined to one body cavity, and particularly when the wound is low in the chest, damage to spleen, liver, kidneys, alimentary tract and other abdominal organs may have occurred. The direction of a through and through wound may indicate the organs which are likely to have been injured, but a missile does not always travel in a straight line between its entrance and its exit, and where an entrance wound only is present it is impossible to define the track. When there is any possibility of the peritoneum having been breached, the abdomen must be explored.

The chest wall wound itself should be treated by excision and suture. This presupposes that the patient has not to be moved down a casualty clearing line as in wartime, for then delayed primary suture is safer than primary suture. Foreign bodies should be removed as soon as practicable. If they are metallic, great care must be taken in localizing them, and radiographs must be taken just before exploration to ensure that they have not moved. Exploration gives an opportunity to remove clothing and other debris which the missile may have carried in, and which is more likely to cause infection than the metallic foreign body itself. If, however, the foreign body is so small that it is unlikely to be found at thoracotomy, or if it is located in such a site as to make the risk of interference too great, removal should not be attempted.

Non-penetrating Wounds

Road accidents are the commonest cause of non-penetrating chest wounds. A pedestrian, or a cyclist hit by a car, or a driver thrust against the steering wheel in a head-on collision, are the most vulnerable. Train crashes, mine disasters, and falls from buildings and scaffolding, supply a proportion of cases of non-penetrating injury.

CHEST WALL INJURY

Uncomplicated Fractures of Ribs and Sternum

Uncomplicated fractures of the ribs and sternum are best treated by analgesics and, if necessary, intercostal nerve blocks, which are repeated at 12–24-hour intervals, if required, to relieve pain. Strapping of fractured ribs, a once favoured remedy, is mentioned only to be condemned. Strapping sufficiently adequate to relieve pain reduces respiratory movements and encourages collapse and infection of the underlying lung, the very complications it is imperative to avoid.

Relief of pain should be accompanied by postural drainage and breathing exercises to encourage expectoration of bronchial secretions, and to restore full respiratory excursion. Although no involvement of the pleura may be at first evident, either on clinical or radiological grounds, a haemothorax or pneumothorax may appear later; therefore adequate surveillance is essential.

Occasionally a pneumothorax may occur as a complication of the intercostal nerve block, but it will usually resolve spontaneously, only very rarely requiring aspiration.

Fracture of Sternum with Over-riding of Fractured Ends

Fracture of the sternum with over-riding of fractured ends should be dealt with as soon as any necessary resuscitative treatment is completed. Reduction of the fracture may be obtained and maintained by hyperextension, but it is preferable to explore the fracture site, re-oppose the fragments and maintain apposition by wire sutures.

Because of the anatomical proximity of the sternum to the mediastinum, the structures in the latter are often injured as well. Pericardial effusion, haemopericardium, tears of the pericardium, with possible herniation of the heart into the pleura, contusions of the heart muscle, and damage of the coronary arteries, may all occur. Radiographs, serial electrocardiographs and serum enzyme estimations are required to exclude or confirm the presence of these complications. The possibility of fracture of the thoracic spine must be borne in mind.

Flail Chest

With increasing numbers of fractured ribs, especially where the fractures are double, or where a fractured sternum coexists, the chest wall will be mobile and paradoxical movements occur. Some surgical emphysema may be present. The lesser degrees of flail chest, where no complications exist, merely require treatment for pain. Gradually the chest wall will become firm and the paradoxical movements cease.

Stabilization

As the size of the flail area gets larger, or if there is pre-existing pulmonary disease, the paradoxical movements interfere with pulmonary ventilation and dyspnoea occurs. Stabilization of the chest wall is necessary. This can be carried out in one of two ways:

Open operation.—The fractures are exposed, reduced and maintained in position by wire, screws, plates or intramedullary nails. General anaesthesia is required.

Traction.—This is applied to the flail segment to stabilize the chest wall and abolish the paradoxical respiration. Local anaesthesia only is necessary. Steinmann pins may be inserted deep to the muscles and traction applied to these by means of a spreader, a cord weight and pulley, and a beam. Alternatively, umbilical tapes or wires protected by polythene tubing may be threaded round one or more ribs deep to the periosteum, and then attached to a weight and pulley. The size of weight will vary from patient to patient, but should just be sufficient to abolish the paradox; as little as 5 pounds or as much as 20 pounds may be needed. The angle at which traction is applied may have to be altered by trial and error to that which is most comfortable and requires the least weight to maintain stability. Provided pulmonary ventilation is now adequate and bronchial secretions can be expectorated,

no further treatment is necessary. If these conditions do not exist, tracheostomy must be considered.

MAINTENANCE OF RESPIRATORY EFFICIENCY

Sedation

A painful chest wall wound restricts respiratory movements and prevents effective coughing. Morphine is the drug of choice but the dose must be sufficient to alleviate pain without depressing the respiratory centre.

Tracheostomy

A tracheostomy reduces the dead space air by between 100 and 150 c.c. The resistance of the upper air passages to respiration is abolished and the frequent and thorough toilet of the tracheo-bronchial tree is facilitated.

"The time to do a tracheostomy is when considering whether or not it should be done" (Borrie, quoted by Barrett 1960). Certainly it should be done early rather than late. Tracheostomy calls for a surgeon skilled in the procedure; it is best performed in an operating theatre with endotracheal anaesthesia. As large a tube as can comfortably be accommodated in the trachea should be inserted, and a cuffed tube is a necessity when there is any risk of inhaling gastric contents.

Well-trained nurses must be available for the post-operative care. Large lumen aspirating catheters should be used and they must be kept clean and sterile; suction sufficiently powerful to aspirate thick tenacious sputum is essential. The patient's life depends on this, for if he is unable to get rid of his sputum before the tracheostomy he certainly cannot do so after it. The bacteriological content of the sputum and the sensitivities of the flora to antibiotics should be investigated daily, so that the appropriate drug may be given. The inner tube requires cleansing every 4 hours, often more frequently, since it must never be allowed to crust up. Respiratory obstruction cannot occur in the presence of a well-cared for adequate tracheostomy.

The moist nasopharyngeal mucosa is by-passed by a tracheostomy and air enters the trachea with a humidity much below its normal. The tracheobronchial secretions may thicken and eventually form crusts, which may increase to occlude the airway completely, perhaps in a few hours. This is even more likely to occur when dry gases are being inhaled instead of atmospheric air. An apparatus, such as the Radcliffe Humidifier, must be employed to provide 100 per cent humidity.

Diagnosis of Respiratory Insufficiency

Respiratory insufficiency may still be present or may develop during the next few hours or days. It may be due to inadequate pulmonary ventilation, damage to the cardiorespiratory centres perhaps by associated brain injury, or to a period of hypoxia or hypotension due to incompletely corrected shock. When its appearance is delayed, the causes may be pulmonary infection or collapse, filling up of the pleural cavities with blood or air, or gastric dilatation and paralytic ileus.

All these factors may play a part in producing respiratory insufficiency with its resultant oxygen lack and associated carbon dioxide retention.

Respiratory insufficiency may be recognized by both subjective and objective criteria. Subjectively, the patient is anxious and distressed and complains of shortness of breath. Objectively, the visible chest movements and audible respiratory noises are diminished. The respiratory rate increases, the pulse rate quickens and the blood pressure rises. These symptoms and signs demand the institution of some form of artificial aid to ventilation.

The vital capacity may be measured and if it falls to within 100 c.c. of the tidal volume, artificial ventilation must be started immediately. Respiratory insufficiency of this degree should never be allowed to continue untreated, for it will be followed by advanced hypoxia and attendant hypercapnia, the signs of which are peripheral and central cyanosis and cerebral disturbances, varying in degree from a confusional state to increasing depth of coma.

Biochemical tests, such as oximetry and estimation of Pco_2, either arterial or alveolar, may be of great value in monitoring the progress of patients requiring long-term artificial ventilation, but they seldom help in the acute stage.

Intermittent Positive Pressure Respiration

When respiratory insufficiency has been diagnosed, intermittent positive pressure respiration using humidified air or an oxygen-enriched mixture, should be instituted at once. Where there is no tracheostomy, a cuffed oral endotracheal tube may be used for not longer than 12 hours, but in all other cases a cuffed tracheostomy tube is required. This type of respiration may be administered effectively, either manually, when only a simple Water's type of apparatus is available, or mechanically, by one of the many efficient ventilating machines.

Ventilation must be continued until adequate satisfactory spontaneous respiration is resumed; it may be for hours, days or even weeks, the latter particularly where there is associated cerebral injury.

Cuffed tubes must never be overinflated and should be deflated at least once every 4 hours to avoid pressure ischaemia of the mucosal surfaces.

Postural Drainage

Although the major air passages can be cleansed by suction through the tracheostomy or endotracheal tube, secretions will collect and become inspissated in the peripheral bronchi and lead to collapse and infection of the lungs, especially the dependent segments, if the patient is allowed to lie still. No sucker can reach these secretions, therefore the patient must be rolled from side to side frequently, at least once every hour, and the foot of the bed raised so that any sputum is encouraged to gravitate towards the main bronchi from where it can be expectorated or aspirated. Postural drainage is essential whenever intermittent positive pressure ventilation is employed, or whenever a tracheostomy is done.

CRITICALLY CRUSHED CHEST

Certain patients with critically injured chests, on admission, are obviously suffering from severe respiratory insufficiency due to extensive damage to the chest wall and paradoxical movements, or to collapse of the lungs because of

air or blood in the pleural cavities, or to obstruction in the trachea or main bronchi. The immediate cause of death is oxygen lack; treatment must be instituted at once because delay of even a few minutes may preclude any chance of success.

Obvious major haemorrhage must be controlled and a sucking wound closed temporarily with a Vaseline gauze pack.

A free airway must be established. This is best achieved by passing a cuffed endotracheal tube. Anaesthesia, including muscle relaxants, may be necessary in the conscious restless patient but care must be taken to avoid regurgitation and inhalation of the contents of a dilated stomach. Bronchial toilet should be carried out so that bronchial secretions, inhaled blood or vomit, can be removed. Intermittent positive pressure respiration can now provide adequate oxygenation, even where the grossest chest wall instability exists.

The presence and extent of surgical emphysema, the site and size of the unstable areas, the approximate number of fractured ribs, double or single, unilateral or bilateral, fractures of the sternum, the position of the apex beat of the heart, the position of the trachea, the movements of both sides of the chest, and the presence or absence of breath sounds should all be recorded whilst controlled respiration is proceeding.

A radiograph should be taken as soon as possible. Although a radiograph with the patient upright gives most information, a good quality one in the recumbent position may be invaluable, and indeed is the only one that can be taken in most of these cases. The quality must be stressed, as a poor quality film, particularly in the presence of surgical emphysema, may be very confusing. The help of an expert is required for its interpretation.

The presence of air or blood or both in the pleural cavities may prevent expansion of the lungs. Intercostal drainage is necessary. A small incision should be made and through an appropriate cannula a Malecot catheter inserted and connected to an underwater seal bottle, to which a suction pump may be attached. The suction pump must be capable of removing large volumes of air. If air only is to be removed a firm No. 16E catheter is inserted in the second space anteriorly. If blood is to be removed a firm No. 20E catheter is used in the sixth or seventh space in the midaxillary line. These tubes require close supervision to ensure that they do not kink or become blocked by fibrin or blood clots.

Now that adequate ventilation has been established and blood volume has been replaced, the general condition of the patient, provided there are no other complications, will improve.

Other injuries, for example abdominal, genito-urinary, neurological or orthopaedic, may be assessed and any which require urgent intervention may now be treated, but it must not be forgotten that chest injuries may produce symptoms and signs which mimic intra-abdominal lesions.

Definitive surgical treatment for chest injuries can be considered, for example stabilization of the flail chest, or the treatment of intrathoracic complications. A tracheostomy is needed if ventilation has to be continued for more than 12 hours and is probably advisable whenever positive pressure respiration has been required for respiratory insufficiency; it is essential when there is associated cerebral injury.