SURGICAL PROCEDURES IN GENERAL PRACTICE

This is one of a series of articles contributed by invitation

TREATMENT OF INJURIES OF THE CHEST

BY

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Injuries of the chest may be of two types: (I) non-penetrating and (II) penetrating.

I. NON-PENETRATING

It is essential to recall that even with slight evidence of serious injury to the chest wall the damage to the contained viscera may be extensive. This is especially the case with children and young adolescents, in whom the chest wall is elastic and flexible and in whom ribs may remain unfractured in quite extensive crush injuries. Furthermore, if the injury occurs suddenly the pulmonary damage is likely to be more extensive, as the air in the lung will be unable to escape rapidly enough through the trachea.

The most common causes of injuries of this type are motor-car injuries, crush injuries, and falls from a height. Three main groups of structures may be injured, involving laceration of pulmonary tissues, damage to blood vessels, and rupture of the diaphragm. The former two are often found in combination. Laceration of the lung may vary from a small localized lesion to complete separation of the lung at the hilum. Occasionally a larger bronchus, or even the trachea, may be involved. Damage to blood vessels may result in rapid death when the main vessels such as the aorta are involved, but in those who survive for some time after the accident damage to intercostal or mammary vessels may lead to urgent symptoms of haemorrhage.

Laceration of the diaphragm is more common than is realized, and in many cases the injury is not recognized until weeks or even months after recovery. Unless the laceration is incomplete or minimal the abdominal viscera will sooner or later pass into the pleural cavity, producing a diaphragmatic hernia. There are three main phases through which patients who survive rapid death may pass: (1) the period of shock, (2) the period of haemorrhage, and (3) the period of infection.

Period of Shock.—In every patient in whom there has been anything but a minimal injury to the chest shock will be present to a greater or lesser degree. This is shown by a condition of collapse and pallor, with weak and rapid pulse and low blood pressure. With the application of resuscitatory measures the condition of the patient may improve, permanently or temporarily. In the latter case, and more especially if recovery is delayed or the condition deteriorates, the patient will probably pass into the second phase.

Period of Haemorrhage.—In this stage the pulse rate increases, the blood pressure falls, and signs of increasing anaemia and restlessness are apparent. (Rapid estimation of the blood haemoglobin may provide clear evidence of internal haemorrhage.) This period is occasionally associated with increasing dyspnoea, due to the accumulation of blood, or blood and air, in the pleura—haemopneumothorax. Should a valvular opening—that is, one that allows air to escape into the pleura on inspiration which

cannot escape on expiration—be present between the air passages (alveoli, bronchi, or bronchioles) and the pleura, a rapid increase in intrapleural pressure will result, which, unless recognized and treated, may cause death in a short period. This condition is termed “valvular pneumothorax.” When previous pleural infection has resulted in the formation of pleural adhesions laceration of the lung may cause surgical emphysema, the air escaping from the lung direct into the superficial muscles and subcutaneous tissues. The peculiar fine crepitus on pressure is characteristic.

Period of Infection.—Organisms may spread from the lung into the pleura and infect the effusion during the ensuing days. The occurrence of infection in the pleural effusion can only be determined by the withdrawal of a portion of the effusion and its bacteriological examination. (The absorption of blood from the pleural cavity invariably causes pyrexia, sometimes as high as 101°, and an increased pulse rate.)

Treatment during Period of Shock

Every patient with any except minimal injury to the chest will be found in a condition of shock of greater or lesser degree. The treatment does not differ in general from that of shock due to other causes, with the exception that it is rarely advisable to place the patient flat or in an inverted position, as the pressure of the abdominal contents on the diaphragm will interfere with respiration. A reclining posture with the shoulders slightly raised will be found to be most satisfactory.

At this stage complete examination is probably inadvisable, but the presence of any external wound should be eliminated and gentle palpation for evidence of fractured ribs undertaken. The patient is then placed, if possible, in an electric cradle or is surrounded by well-insulated hot-water bottles. Continuous “drip” saline into the bowel may now be begun and an injection of 1/6 grain of morphine given subcutaneously.

It is advisable to record the pulse and respiratory rates and the blood pressure at regular half-hourly, or in severe cases shorter, intervals. In association with these the abdomen should be examined every few hours for any changes, such as localized rigidity, if upper abdominal injury is suspected. Under this treatment a slowing of the pulse and respiratory rates, with a steady rise in blood pressure, will be evidence of recovery, and if a portable x-ray apparatus is available the opportunity for radiological examination should be taken. This is possible with little or no disturbance to the patient, and may afford valuable information on the intrathoracic condition. No immediate operative intervention is called for while improvement is being made.

Treatment of Haemorrhage

This period may be continuous with the earlier period, the patient failing to recover from the period of shock, or deterioration may set in after an initial period of recovery. It will be associated with a rapid pulse and a raised respiratory rate due to the presence of an increased quantity of blood, or blood and air, in the pleural cavity. The blood pressure will be low or failing, increasing pallor be visible, and occasionally restlessness and

sweating be obvious. A rapid estimate of blood loss may be made by use of the haemoglobinometer.

Evidence of intrathoracic haemorrhage calls for a blood transfusion, which should be given after the usual precautions of blood grouping and cross-testing. Improvement will follow unless a larger vessel such as the intercostal or internal mammary artery is involved, when signs of continued haemorrhage will call for operative intervention to control the bleeding vessel.

Increasing dyspnoea, and especially cyanosis with or without signs of persisting haemorrhage, suggest pneumothorax. This will be associated with certain physical signs in the chest such as absence of breath sounds over the upper chest of the affected side, with a high tympanitic percussion note and displacement of the apex beat to the opposite side. The aspiration of air from the pleural cavity is best carried out by means of a pneumothorax apparatus, with a bottle "trap" to prevent any fluid getting into the main apparatus. When this is not available it can be simply performed as follows:

Probably the optimum site is the second interspace anteriorly, about two inches from the sternal edge. The track of the proposed aspiration is anaesthetized with 1 per cent. novocain solution introduced with a fine needle attached to a syringe. The entrance into the pleura is shown by the withdrawal of air into the syringe, and the depth of the pleura from the skin surface is thus determined. A serum syringe needle is connected to about three feet of narrow rubber tubing, and the free end of the tubing is passed under sterile water in a bottle below the level of the bed. The needle is inserted through the anaesthetized area into the pleura, and the excess of air in the pleura will escape through the sterile water in the bottle. When no further air escapes the needle may be withdrawn and the site of puncture sealed with a small piece of wool and collodion.

In "valvular pneumothorax" air will continue to escape from the pleura through the apparatus, and this is an indication to leave the needle, etc., *in situ*. It should be carefully surrounded with sterile gauze and fixed with adhesive strapping to the skin. Again, the needle should be removed as soon as the pulmonary-pleural communication has closed—that is, as soon as air ceases to escape through the fluid.

All these manœuvres should be carried out under the most rigid aseptic precautions, to avoid infecting the pleural cavity.

Emphysema

Surgical emphysema rarely requires active treatment, although occasionally considerable pain and discomfort may result from its spread to the eyelids, scrotum, and labia, in which distension may be considerable owing to laxity of the tissues. In such cases a serum needle may be passed into the subcutaneous tissues over the chest and the air "massaged" towards it. When associated, as is usual, with fracture of the ribs, the fixation of the ribs usually limits the further extension of the surgical emphysema.

Mediastinal emphysema is most likely to result from injury to the trachea and main bronchi. It is of greater import, as usually the escape of air into the tissues is more rapid and the pressure exerted upon the mediastinal veins may obstruct them. The air as a rule escapes to the subcutaneous tissues through the superior thoracic aperture, and relief may be obtained by the use of the subcutaneous needle.

Treatment during Period of Infection

In non-penetrating injuries the blood in the pleura and the effusion poured out as a result of pleural irritation may remain uninfected, or infection may result second-

arily from organisms in the lung or the blood stream. As the absorption of blood-stained effusion in the pleura is often accompanied by pyrexia, even up to 101°, and a raised pulse rate, the only certain evidence of infection is by the aspiration of some of the pleural fluid and its bacteriological examination.

In uninfected cases only such a quantity as will relieve symptoms is aspirated from the pleural cavity, as excessive withdrawal of blood will cause expansion of the lung and possibly induce further bleeding from reopening a laceration in the lung tissue. Where symptoms are not urgent the blood effused should be left for a few days and aspirated gradually over several days until the pleura is empty and the lung fully re-expanded. Occasionally the replacement of the effusion by sterile air will permit gradual pulmonary expansion. When bacteriological evidence proves infection of the blood-stained effusion a proportion of the pleural contents should be removed by aspiration on alternate days. The fluid will gradually thicken and become more purulent, until eventually a localized empyema is formed. It is now safe to carry out a rib resection and employ adequate drainage as for the more common post-pneumonic empyemas. The presence of haemolytic streptococci in the pleural exudate indicates the employment of drugs of the sulphonamide group in association with the above treatment.

It is dangerous to employ open drainage before the formation of frank pus.

Fracture of Ribs and Sternum

In association with contusions of the chest the bones most commonly fractured are the ribs, sternum, and scapula. The ribs may be fractured by indirect or by direct violence, the latter resulting in the condition of "stove-in" chest, each involved rib being generally fractured at two or more points. The deformity produced by direct fracture is diagnostic; in the indirect fracture the diagnosis is made by the acute localized pain on deep respiration. Antero-posterior pressure to the chest wall will also cause pain at the site of fracture and not at the points of pressure. In either case bruising, even to the extent of a large haematoma, may be found in association with the bony injury, and this may disguise the depression often present in fracture due to direct violence.

The treatment for the more common fractures due to indirect violence is by fixation of the chest wall. Adhesive strapping is applied, either direct to the skin after shaving or over a thin cotton vest, in overlapping layers. The strapping, about three inches wide, is applied in layers, usually three in number, from below upwards. Each portion is fixed during the phase of full expiration, and should extend well over the middle line in front and behind. Some surgeons advise that the strapping should be applied completely around the chest, as greater control of mobility is thereby attained.

The sternum is comparatively rarely fractured, and the diagnosis is obvious owing to the deformity produced. The lower fragment usually overrides the upper fragment, and forms a protuberance beneath the skin. Reduction is attained by placing the patient on the back with a sand-bag between the shoulders. The arms are then extended above the shoulders and brought downward, while pressure is maintained from before backwards on the upper end of the lower fragment. Although reduction may be relatively easy, retention in the normal position is difficult to maintain and redisplacement frequent. An attempt should be made to maintain reduction by placing a firm pad over the line of the fracture and fixing it in position

with adhesive strapping. Should recurrence take place, operative retention by the use of sutures uniting the fragments will be necessary.

The treatment of fractures of the clavicle and scapula has been dealt with elsewhere in this series and does not require further description.

Injury to the Diaphragm

Laceration of the diaphragm of varying extent occurs in a small proportion of contusions of the chest. As a rule there are no distinctive symptoms in the early stages, and in radiographs the opacity in the lower chest caused by the abdominal contents herniated through the laceration in the diaphragm is mistaken for effusion or consolidation of the pulmonary tissue. At a later stage symptoms such as continued but indefinite indigestion or acute pain in the lower chest or upper abdomen, often associated with vomiting due to partial strangulation of the hernial contents, result in investigation by barium meal and radiographs, which make the diagnosis obvious.

The treatment is operative, and the prognosis, if strangulation has not occurred, is good. For traumatic diaphragmatic hernia approach through the chest is more satisfactory than that obtained through the upper abdomen, since the laceration can be more easily exposed and separation of omentum and hollow viscera adherent within the chest is easier and safer.

II. PENETRATING WOUNDS OF THE CHEST

The essential differences between the non-penetrating and the penetrating wounds of the chest are the greater incidence of infection, the production of an "open pneumothorax," the increased frequency of cardiac wounds and the occasional presence of a retained missile. Where these factors are not concerned the treatment of such injuries is largely that of the non-penetrating type. In all cases in which there is a lacerated wound excision and suture should be carried out as soon as the general condition of the patient permits, in order to obviate the risks of infection.

Open Pneumothorax

The presence of a lacerated penetrating wound which permits the entrance and egress of air into and from the pleural cavity has a very serious effect upon the respiratory function. The opening should therefore be closed as soon as possible. When conditions do not permit of immediate excision of the wound and closure of the chest wall by suture the wound edges should be firmly drawn together and fixed by adhesive strapping so as to prevent the free interchange of air between the pleural cavity and the exterior. The "débridement" should be undertaken as soon as possible to prevent infection. Subsequent treatment will depend upon the occurrence or otherwise of infection.

Retained Missiles

The question of the removal of retained missiles will depend upon their nature. Bullets, revolver or rifle, and smooth missiles such as shrapnel balls, can generally be left during the early days and the necessity for their removal decided at a later date. When irregular missiles are retained it is probable that portions of clothing have been carried in ahead of them. In such cases infection is almost certain to occur, and the question of their removal is a much more urgent problem. As soon as

the general condition of the patient permits they should be removed after careful radiological localization.

Cardiac Wounds

Suspicion of cardiac injury should always be aroused when penetrating wounds are situated over the precordial area. A considerable degree of success has followed exploration and suture of stab wounds of the heart, and it is essential to recognize the symptoms of haemorrhage into the pericardium, on which the diagnosis is chiefly based. The effusion of blood into the pericardium causes increasing difficulty in cardiac action, a condition termed "cardiac tamponade." The three cardinal symptoms are: (1) muffling of heart sounds—so-called "silent heart"; (2) falling blood pressure; and (3) rising venous pressure.

It is important to recall that cerebral symptoms can result from haemorrhage into the pericardium. These symptoms may comprise stupor, generalized rigidity with muscular twitchings, and occasionally hemiplegia, and are caused by cerebral anoxaemia. When the chest injury is associated with a head injury considerable difficulty may be experienced in deciding whether the symptoms are caused by direct cerebral injury or not. In such cases radiography may be most helpful, as when there is cardiac tamponade the cardiac shadow is enlarged and is often associated with pleural haemorrhage.

Cardiac injuries require treatment as soon as the diagnosis is determined, and the pericardium should be opened and the cardiac wounds sutured.

Late Results of Chest Injuries

In contusions and penetrating wounds in which a haemothorax is not aspirated and full expansion of the lung not attained after a period of some months, there is a tendency for calcification to take place in the walls surrounding the encysted blood—that is, parietal and visceral pleura. As this will result in restricted mobility of the chest wall and diminished functional capacity of the lung, and the fluid contents may subsequently become infected months or years later, it is essential to remove all blood-stained effusion from the chest by aspiration and ensure full pulmonary expansion and function.

Apart from diaphragmatic hernia, there is another late sequel to chest contusion, especially when it has been severe and has caused damage to the bronchial wall—namely, bronchial stenosis. This may be partial or complete, and may result in pulmonary atelectasis, often associated with secondary infection, and require lobectomy or even total pneumonectomy.

Lastly, the retention of a foreign body which has caused no trouble for months or even years may result in the formation of a pulmonary abscess, and give rise to secondary bronchiectasis and repeated haemoptyses.

These conditions will require treatment according to accepted principles. The control of the whole period of observation by repeated x-ray examinations will not only enable the immediate treatment to be carried out on the right lines, but will in many cases prevent the establishment of changes that will only be apparent months or years later.

In conclusion it will be seen that in the treatment of chest injuries it is inadvisable to intervene surgically in the early stages unless the evidence for such intervention is definite, and, likewise, that in the majority of cases all that is required later is aspiration of the contents of the pleural cavity.