SUDDEN COMPRESSION INJURIES OF THE ABDOMEN AT SEA

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In contrast to the extensive literature on blast injuries of the lung, reports on the effect of sudden compression of the abdomen are few and brief. It has been recognized in this, as it was in the last war, that compression or suction waves set up by the detonation of high explosives on land or at sea cause, among other lesions, bleeding into the lungs and abdominal viscera. Atkins (1940) describes the cases of three patients, injured by depth-charge explosions while they were swimming, who came under his care suffering from peritonitis after the Dunkirk evacuation. All were operated upon: one had a perforation of the ileum three inches above the caecum; the second had a similar lesion in the first part of the ascending colon; while the third showed multiple petechial haemorrhages with oedema in the walls of the intestines but no perforation. The third of these died, but the first two, after suture of the perforations, survived. Atkins says that prognosis in these injuries is usually bad because of associated lacerations of the brain and lungs. Gordon-Taylor (1940) has noted bowel rupture without breach of the skin in shipwrecked men injured by depth-charge detonations. He believes that organisms permeating a contused colon may be the cause of an abscess or even a faecal fistula. Below we record two such abscesses, one pelvic and the other subphrenic, which may have been due to this cause. Gordon-Taylor also describes a group of patients who suffered from severe melaena but recovered without serious complications. We record the cases of seven such patients who developed varying degrees of haematemesis and who all recovered. Wakeley (1941) also has noted compression injuries in sailors.

Clinical Features

The case histories fall into three groups: (A) obvious abdominal injuries that recover completely without operation; (B) severe injuries, such as lacerations, disclosed at operation; and (C) late complications, such as abscess formation.

It is clear that immediate fatalities are numerous, but we have no data regarding these. This report deals with survivors from a convoy attacked by submarines, and all were rescued by small ships, in which immediate operations such as laparotomy were not possible. We have nothing new to add to the well-known principles which enable the surgeon to decide whether he should operate or not in recent abdominal injuries. The happy fact is that, out of ten survivors seen, nine recovered without immediate operations, though grave symptoms such as shock, haematemesis, melaena, and pyrexia were present in most.

Group A

Haematemesis; Melaena; Abdominal Pain; Complete Recovery in Seven Patients

The clinical features were so similar in all the cases of this group that the description of only one case is given.

Case 1.—The patient, an Allied naval officer aged 27, was swimming in the sea after his ship had been torpedoed, when depth charges from the sinking vessel, which was thirty yards away, detonated on sliding into the water. He felt a "sudden electric shock," but did not lose consciousness, and reached a raft. He was rescued by a small naval ship and walked to a cabin unaided. Within an hour of the explosion he vomited a good deal of blood and developed hiccup and much abdominal pain. When examined by a surgeon lieutenant who had been put on board, the lower abdomen was found to be rigid and tender. The patient was treated with morphine and was allowed fluids. He complained of a good deal of pain in both testicles. The next day he required catheterization, but there was no blood in the urine. Throughout the day he had diarrhoea, with obvious blood in the stools.

Three days later he was put ashore. He was pale and exhausted; his temperature was 99° and his pulse 100. The abdomen was tender, especially in the left epigastrium, but there was no true rigidity; there was a moderate generalized distension and no evidence of free fluid or loss of liver dullness. He vomited twice in the first twenty-four hours, and diarrhoea with melaena continued for two days. The urine was free from blood. The blood count and haemoglobin were normal. Fluids only by mouth, together with tinct. opii, mxx, t.d.s., were given for three days, when the diet was gradually built up. Four days after admission there was still tenderness, but the tender areas varied, sometimes being in the left and sometimes in the right epigastrium; occult blood was present in the faeces. He suffered a good deal of pain in the lower part of both sides of the chest, and had a little sputum, but there were no notable physical signs, and a chest radiograph taken four days after admission showed no pathological features. A slow recovery, uneventful except for a daily pyrexia of 99° to 100.5° for ten days, followed.

In the other six patients of this group the clinical symptoms were very similar, though of varying degrees of severity. Two other patients complained of severe bilateral testicular pain. No patient had blood in the urine, and the testicular pain was probably due to compression and not to referred pain.

Group B

Laceration of Ileum; Peritonitis; Compression Injuries of Lungs; Laparotomy and Suture of Perforation; Ether Convulsions; Death

Case 2.—A lieutenant of the R.N.V.R. aged 26 sustained injuries when a torpedo struck his ship. He was trapped in a compartment flooded with oil, and was rescued from the water within an hour of the explosion. He was able to walk to a cabin though suffering from severe vomiting. When seen by a surgeon lieutenant four hours after the sinking the pulse was 80 and the temperature 100°; he complained of abdominal pain with tenderness in the right iliac fossa. Twelve hours later the pulse was 96 and the temperature 103°, and he coughed a good deal. He was unable to pass urine, and had severe pain in both testicles. Twenty-four hours after the attack on the ship he was restless, the pulse was 120, he passed blood and mucus per rectum, and coughed up some darkly stained frothy mucus that contained fuel oil. At this time he was in a corvette actively engaged against the enemy, and laparotomy was quite impracticable. Thirty-eight hours after being torpedoed he was put ashore with the diagnosis of "possible rupture of a viscus or subperitoneal haemorrhage." On admission to hospital he was restless and exhausted, with a temperature of 101° and a pulse of 110. The abdomen was not rigid, but there was considerable tenderness in the right iliac fossa. He was also dyspnoeic. Immediate operation was considered inadvisable because of the patient's poor general condition and the uncertainty of the diagnosis. Resuscitation measures included morphine, a pint of plasma, and 1½ pints of saline and glucose given intravenously throughout the night. A considerable improvement followed, but fifty hours after the torpedoing he presented unmistakable signs of spreading peritonitis in the lower abdomen, and operation could not be deferred. The blood picture was normal and the haemoglobin 90%; there was no blood in the urine. The stomach was washed out and the tube left in place while intratracheal gas, oxygen, and ether were administered (Major T. H.

Hobbes, R.A.M.C.). Laparotomy disclosed a small tear in the ileum, about three feet above the caecum, which was closed by Lembert suture. There was gross distention of the intestines, and early general peritonitis with reddening of the peritoneum and exudate was seen. Many haemorrhages were found in the subperitoneal tissues. As the peritoneum was being opened ether convulsions developed; these were checked by intravenous sodium pentothal (0.5 gramme). On return to the ward the breathing was laboured and much frothy sputum was expectorated, and he died 4½ hours later, oxygen being given continually. A detailed necropsy account (see below) reported the presence of "pulmonary concussion."

Group C

Complications developing Some Days after Original Injuries

This group includes the cases of two sailors who survived what were severe original compression injuries, treated by conservative measures, but who developed localized abscesses which were treated successfully by drainage.

Case 3: Abdominal Compression; Haematemesis; Pelvic Abscess; Testicular Pain.—This patient, an A.B. aged 26, was injured by depth-charge detonations while in the water. He was admitted three days later in good general condition but with much generalized abdominal pain accompanied by guarding below the umbilicus. Temperature 100°, pulse 96. Before admission he had had considerable haematemesis but was constipated; an enema shortly after admission yielded a good result and relieved the abdominal pain. He had pain in both testicles, and the faeces contained occult and fresh blood. His general condition improved, but the lower abdominal pain persisted until the ninth day after admission, when he passed mucus. A rectal examination revealed a tender non-fluctuant mass in the rectum. A pelvic abscess was diagnosed; this was opened through the rectal wall two days later, when it was soft and fluctuant. Complete relief of symptoms followed, and the patient made an uninterrupted recovery.

Salient features of the case are: (i) The gradual development of the abscess without alarming symptoms. (ii) At no time was there evidence of a serious intraperitoneal catastrophe; the pulse was always under 100, and the temperature was never over 100°; nor did abdominal rigidity develop. (iii) The total white blood cell count never exceeded 14,000. (iv) The testicular pain. (v) It is impossible to know whether the abscess followed a small rupture or was due to permeation of organisms through a bruised segment of intestine.

Case 4: Compression Injuries; Haematemesis and Melaena; Right Posterior Subphrenic Abscess; Drainage; Right Pyothorax; Intercostal Drainage; Rib Resection; Recovery.—This patient, an A.B. aged 30, was admitted on the same day and from the same incident as the preceding patient. For three days at sea he had had persistent vomiting and haematemesis, with diarrhoea and blood in the stools. His general condition was poor, being decidedly worse than that of his colleague, and he could retain only iced water by mouth. Abdominal pain was general, but no area of local tenderness or rigidity existed; there was no general distension and no loss of liver dullness. The pulse rate never exceeded 90, and there was no indication for laparotomy, since the condition was improving rather than deteriorating when he was seen on the third day. Two days later all vomiting had ceased, but diarrhoea continued, with blood in the slate-coloured stools. The abdominal pain and tenderness had decreased. Six days after admission the temperature, which had been in the region of 99°, began to rise, and nine days after admission it reached 102°, with a pulse of 90. The white blood cell count was 25,000. Tenderness was present over the liver area and dullness and impairment of breath sounds were detected at the right base. A radiograph showed a raised right diaphragm, and there was an abscess cavity with a fluid level (Major W. N. Brown, R.A.M.C.). From this abscess foul pus was obtained by needle. Bacteriological examination showed a mixed infection from which non-haemolytic streptococci were isolated. Under general intratracheal anaesthesia (Major E. Fowler, R.A.M.C.) a portion of the ninth rib was resected posteriorly; the diaphragmatic and parietal pleura were adherent, and transdiaphragmatic drainage of a large abscess

was instituted. The abscess drained well, but the temperature persisted, and physical signs and radiology disclosed a large pleural effusion six days after the first operation. Twenty ounces of thin foul pus was extracted by Potain's apparatus, and the next day an intercostal drainage was established, as a tension pneumothorax, the result of gas formation, had developed. His condition, which had been grave, improved steadily. Five days after the operation a pint of blood was given, and three days later better drainage was effected. Under intratracheal gas-and-oxygen (Major E. Fowler) a portion of the seventh rib was resected posteriorly and closed drainage into a water-sealed bottle through a Tudor Edwards tube was carried out. The temperature slowly subsided, and eight days afterwards was normal. The general condition improved and the patient developed a voracious appetite. At the time of writing a tube is still in the cavity and the lung is re-expanding satisfactorily.

Salient features of this case are: (i) The initial symptoms and the absence of signs pointing to definite visceral rupture. (ii) The slow development of a subphrenic abscess in a patient in a high Fowler position throughout; this suggests a small laceration or severe contusion of the stomach, duodenum, colon, or liver. (iii) The development of a large pyothorax with gas formation sufficient to cause a tension pneumothorax, and its satisfactory relief by drainage.

Pathology of Sudden Abdominal Compression

Lacerations do occur, but in many survivors the main feature is subperitoneal haematoma. The following necropsy report is given because it represents a picture of a severe case in which lung "blast" coexisted. It must be realized that in the other nine patients in this series the clinical feature of pulmonary concussion was not present, and it is probable that in "blast" injuries at sea the abdomen is affected more than the chest, and in this way contrasts with the picture seen in the blast injuries of air-raid casualties. In this respect it is important to note that the report given below refers to a patient damaged by torpedo explosion while he was in an enclosed space and not to a sailor injured by depth charges as he was swimming. The casualty in the water may well escape pulmonary concussion because the concussion wave acts chiefly on the abdomen. The presence of testicular pain in so many survivors is noteworthy in this connexion and is probably due to a direct underwater compression. The absence of external bruising in any patient of this series is striking.

Post-mortem Findings in Case 2, the Only Fatal Case

External Appearance of the Body.—A well-built man. There were no cutaneous or subcutaneous haemorrhages and no superficial abrasions. The recent abdominal surgical incision was healthy.

Thorax.—The pleural cavities were normal and did not contain free fluid. There were no haemorrhages in the parietal pleura, but small petechiae were numerous on the surfaces of the lower lobes of both lungs, especially the right. The trachea and bronchi were filled with frothy blood-stained mucus. The lungs were engorged and oedematous. There were many small haemorrhages, which were noticed only after fixation of a portion of the lung tissue. The heart and pericardium were normal and did not show any evidence of blast injury.

Abdomen.—The peritoneal cavity contained about a pint of blood-stained turbid fluid, and there was an acute diffuse fibrinopurulent peritonitis. No haemorrhages were present in the parietal peritoneum, but the visceral, especially that covering the distal loops of the small intestine, was studded with small haemorrhages, most of which were about 0.5 cm. in diameter. They were more numerous in the right side of the abdomen than on the left, and were particularly prominent along the line of attachment of the mesentery. There was an extensive extravasation of blood in the loose tissue in the vicinity of the hepatic flexure of the colon. The solid viscera were all undamaged. The stomach was engorged and showed pin-point haemorrhages on its inner surface. The duodenum was normal.

Starting from a point eight to ten feet from the duodeno-jejunal flexure and extending to the lower end of the sigmoid colon were many submucous haemorrhages similar in size to those visible on the peritoneal surface. They were most striking and numerous towards the distal end of the small intestine, where there was a perforation about three feet from the ileo-caecal valve. The degree of haemorrhage around the perforation was not enough to suggest that the latter had resulted from the weakening of the intestinal wall by an extravasation of blood. In the colon many of the haemorrhages were more diffuse, and over a particularly extensive one the mucosa had ulcerated.

C.N.S.—The brain was examined and found to be healthy.

During the course of the necropsy the abdominal wall was examined for intramuscular haemorrhages, but none was found.

Histological preparations were made from the lungs and small intestines. In the lung were found scattered intra-alveolar haemorrhages and oedema, separated by patches of normal tissue and areas of congestion with haemorrhage limited by the alveolar walls. In the oedematous patches there were many carbon particles and some basophilic debris. Many macrophages were present dealing with these foreign bodies, which were attributed to the inhalation of sea-water and fuel oil. Sections of the ileum showed the haemorrhages to be most severe in the submucous and subperitoneal layers of the intestines, but haemorrhages into the muscle layer were also observed. The sections showed that the haemorrhages were more diffuse than was expected from the naked-eye appearance of the gut. At the site of the perforation there was haemorrhage into the adjoining tissue, but not a great deal.

Discussion on the Post-mortem Findings

The patient suffered from ether convulsions during the laparotomy, and at the time of his immersion in the sea he inhaled sea-water, so we must attribute the oedema and congestion of the lungs to these; but the haemorrhages were similar to those which we have learnt to associate with bomb blast and which have been described a number of times in the literature.

There have been descriptions in the literature of abdominal injuries as the result of explosions at sea under circumstances similar to those in this instance. The interest of this case is that, when the above post-mortem findings are borne in mind, we can trace the course of events in the other patients of this series who recovered.

Note on Examination of Fish Killed by Depth Charges

No experiments were carried out to study injuries produced in mammals by underwater blast, but three fishes killed by depth charges were examined. Two of them did not show any naked-eye injuries either in the body cavity or in the brain, but one had an extensive extravasation of blood in the posterior part of the coelom. We are indebted to Surgeon Commander Button, R.N., and Surgeon Lieut.-Commander Carleton, R.N., for obtaining these specimens for us.

Summary

Sudden compression waves produced by torpedo and depth-charge explosions in ten patients showed their chief effects in the abdomen and caused subperitoneal and submucous haemorrhages and lacerations of the intestine. There was clinical evidence of submucous haemorrhages, shown by haematemesis and melaena in ten patients.

Seven patients recovered completely without operation; two others recovered after drainage of a pelvic abscess in one and after drainage of a subphrenic abscess and an empyema in the other; one patient died after an operation for a tear of the small intestine; the post-mortem results are described in detail. In addition to the abdominal injuries blast effects in the lung were seen. In none of the other nine patients were there symptoms or signs of severe blast lung injury, apart from a little haemoptysis in one.

The immediate symptoms after sudden compression were not severe.

The presenting symptoms were vomiting with blood in the vomit, diarrhoea with melaena, and considerable testicular

pain in four cases. The last-mentioned symptom was probably due to a direct compression effect. Abdominal tenderness and slight rigidity were present for several days in the nine surviving patients.

There was no external bruising in any patient.

As none of the patients were seen in the first twenty-four hours it is difficult to assess the indication for immediate operation. In the one case with a perforation, the indication of a spreading peritonitis led to a laparotomy on the third day, though it is recognized that this is always a bad time for operation. In the two patients who developed abscesses it is possible that these followed the permeation of organisms through a contused bowel wall.

The results justify the adoption of a conservative management of such patients, especially if seen after twenty-four hours.

In neither of the two abscess cases were there positive indications demanding immediate laparotomy.

We must record the devoted care given at sea to these patients by Surgeon Lieut. J. B. MacIntosh, R.N.V.R., and Surgeon Lieut. R. Aston, R.N.V.R., and thank them for their accurate records, made under great difficulties.

REFERENCES

- Atkins, H. J. B. (1940). *Guy's Hosp. Gaz.*, **54**, 192.
Gordon-Taylor, G. (1940). In *Surgery of Modern Warfare*, ed. by H. Bailey, p. 224, Livingstone, Edinburgh.
Wakeley, C. P. G. (1941). *Lancet*, **2**, 199.

ACUTE RELAPSING DERMATITIS DUE TO NAIL VARNISH

BY

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In view of the extensive use of nail varnish the following record of a case of nail lacquer dermatitis may be of interest.

Case Report

The patient, a married woman aged 37, was referred to me by her medical attendant on November 6, 1941, with the following history. Nine weeks earlier "three or four red patches appeared on the right side of the face over the mandible and spread thence to the neck. An application of linimentum calaminae cleared these up in about a week, but a few days later they recurred in the same situation, spreading upwards over the right half of the face and producing oedema of both eyelids, associated with erythema and superficial exfoliation. Before this attack had completely subsided it was followed by a third, which spread downwards on the neck in urticated patches. These coalesced, and suggested, when the ears became affected, a picture resembling seborrhoeic dermatitis. On November 1 the rash had spread to the left side of the face and to the flexor aspects of both forearms, but neither the hands nor the fingers were involved." The patient confirmed these observations and stated, further, that she had had several attacks of hay-fever due to grass pollens in previous years, and one attack of dermatitis attributed to tulips, thus testifying to an allergic diathesis.

On inspection the main site of her present attack was on the right side of the face and neck, with subsiding oedema of both eyelids and slight exfoliation of the right auricle. The scalp, forearms, and hands showed no sign of inflammatory response, but there were two small symmetrical patches of diffuse dermatitis with erythema and branny scaling in both popliteal spaces. (The significance of these will become evident at a later stage.)

The rash was evidently an allergic response to some external antigen, although, as in so many of these cases, the actual agent was not suspected by the patient. While I was cross-examining her as to her habits in the use of cosmetics, her hobbies, and her pets, etc., I was struck by two very obvious facts—the high degree of polish on her carmine-dyed finger-nails, and her tendency to rest the right cheek and chin against the dorsal surface of her right hand, held in a semi-clenched position so that her fingers and finger-nails were in direct contact with the