SEVERE ABDOMINAL CRUSH INJURY

A STUDY OF THE MECHANICS IN AN EXTREME CASE

BY

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Trauma in the case here reported took the form of a powerful antero-posterior crushing force applied to the left thoraco-abdominal region. The important grosser effects were as follows: Rupture of the spleen in the hilar region; complete transverse tearing of the jejunum, with partial detachment from the mesentery; severe laceration of the pancreas; bruising of the transverse colon; and detachment of the greater omentum over practically the whole length of the transverse colon. Yet, with early and carefully graded resuscitation, and with minimal and speedy operative intervention, this patient recovered.

As an extreme example of recovery from gross injury the case has considerable interest. It is, however, as an illustration of the mechanics of injury that I report it. This latter question, with its bearing on operative treatment, is discussed below.

Case Report

On April 18, 1944, a civilian R.E. employee, aged 36, was working on a railway track beside stationary wagons and was not warned of the immediate approach of another truck. His left lower chest and upper abdomen were trapped between the buffers and he was subjected to a powerful crushing force. On release he was breathless, faint, and had severe abdominal pain. He was admitted to hospital one hour later, and severe shock was manifest in his facies and pale clammy skin. A temperature of 96° was recorded, but the pulse rate and blood pressure were little upset. These were respectively 76 and 118/88. Apart from slight bruising, there was no external evidence of trauma. Both lower limbs moved freely, there was no cutaneous anaesthesia, and the reflexes were normal. His abdomen was rigid but not boardlike, and shifting dullness was elicited in both flanks. The epigastrium and left hypochondrium were extremely tender on examination. Resuscitation was instituted immediately, and included the giving of morphine, plasma, and blood. Three hours after admission the pulse reading was only 90, but the volume not so good as previously. The blood pressure was now 120/85. The patient complained of severe abdominal pain, and this was not relieved by morphine. The abdominal rigidity persisted but was still not boardlike, and the abdomen seemed generally fuller. Dullness had spread medially, and was now generalized. A catheter was passed and 8 oz. of clear urine withdrawn.

The picture was that of a severe progressive internal haemorrhage. The patient was becoming more restless, the pulse was not so good, and operation was planned on a provisional diagnosis of rupture of the spleen.

Operation.—Major Sington, R.A.M.C., administered ethyl chloride, oxygen, and ether anaesthesia. The operation was begun five hours after admission, and a blood-drip transfusion was running throughout. A midline upper abdominal incision was used; the peritoneal cavity, when opened, was found to be full of blood. The omental fat was undergoing patchy necrosis, and the presenting small intestine and transverse colon showed superficial pancreatic digestion. The spleen was enlarged by a subcapsular haematoma, and was bleeding freely over the hilar aspect. The lesser sac had been torn open on the left side, and it was comparatively easy to clamp the splenic vessels and remove the spleen. Much laceration of the pancreas over the body and tail was noted, besides considerable subcapsular haematoma formation (see Fig.). Severe haemorrhage was still in progress below the transverse mesocolon, and was then investigated. The greater omentum had been ripped off practically the whole length of the transverse colon, but was not bleeding. The transverse colon itself showed a good deal of bruising, but was not ruptured. It was in the normal position and freely mobile. Two torn ends of jejunum were presenting anteriorly from a pool of blood: the bowel had been divided completely across and the distal segment torn from its mesentery for a distance of about 6 inches. The site of rupture was about 3 inches from the duodeno-jejunal junction. Haemorrhage from the mesenteric vessels was profuse. Major Sington warned us of the patient's extremely poor condition at this stage, and gave nikethamide 1 c.cm. and strychnine 1/30 gr. A very rapid resection of the 6 inches of jejunum and an end-to-end anastomosis were performed. Without further delay the wound was closed in one layer with interrupted sutures. The patient was returned to bed in rather poor condition. Before, during, and immediately after the operation five pints of plasma and two pints of stored blood were given.

Subsequent Progress.—Continuous gastric suction and intermittent intravenous infusions were kept up for 72 hours post-operatively.

On the first day the general condition was fair, with a pulse rate of 110 and a blood pressure of 110/75, but less good on the second day, when the pulse rate was 130, the tongue dry, and the abdomen rather distended. The bowels moved during the night, and with the relief of distension the abdominal condition improved from the third day.

Simplified and diagrammatic illustration of gross and obvious injury to the spleen, pancreas, and greater omentum. An equally severe jejunal injury, however, is obscured by the transverse colon and mesocolon. Application of the mechanics of injury precludes missing the latter lesion at operation.

The following complications were encountered:

1. **Post-traumatic Pneumonia.**—From the second day the left lower lobe showed evidence of oedema and, later, of patchy consolidation. This was almost certainly associated with the compression force applied here.

2. **Pulmonary Embolus.**—On the fifth day the patient experienced a sudden severe pain in the left side of the chest. There was a localized area of friction overlying it in the left mid-zone.

3. **Jaundice.**—Clinical jaundice developed on the fourth day and gradually deepened. It faded after eight days and gave rise to no symptoms. As stated above, stored-blood transfusions were used.

4. **Wound Digestion.**—The wound was red and angry-looking for the first ten days, especially around the sutures. This was no doubt due to the leaking pancreatic ferments causing tissue digestion.

5. **Rectal Haemorrhage.**—Twenty-four days after injury, and when he had been up for three days, the patient felt sick, faint, and giddy. He passed a large stool with considerable bright-red blood, and a little the next day also. Recovery from this was uneventful, and I can only suggest that its origin was connected with the bruising of the transverse colon noted at operation.

Seven weeks after injury the patient was discharged to convalescent hospital. He was in good health and had no symptoms. A follow-up x-ray examination showed no hold-up in the passage of barium through the alimentary tract.

Discussion of Mechanism

Injury to the spleen in this case demonstrates the simple crush mechanism. The spleen is caught between the two external forces and compressed. Rupture is essentially of a bursting type.

Jejunal injuries of the character encountered here are due to nipping of the bowel between the anterior force and the

vertebral column. The force is shearing in nature. Owing to fixation at the duodeno-jejunal junction, and by virtue of its short compact mesentery, the gut has limited mobility at this level. This is especially so in the vertical plane. Consequently it is comparatively easily trapped and injured against the vertebral column. The severe pancreatic damage bears witness to such a mechanism in this particular case, and has the same origin.

With regard to the transverse colon, it is interesting to note that the conditions governing the small-intestine injury do not hold. The long mesentery allows of bowel escaping or slipping out from between the anterior and posterior forces. The bruising and trauma in the colon noted at operation seem to indicate this. The apron-like omentum, on the other hand, would not so escape, and must needs be trapped against the vertebral column by the anterior force. The pull thus thrown on the junction of the transverse colon and greater omentum shows itself in the tearing apart of the two structures.

Recognition of visceral damage at operation is facilitated by a realization of these points. The dual mechanism should be kept in mind, and may help one to avoid a possible pitfall. The persistent bleeding coming up from below the transverse mesocolon gave me the clue, and the torn ends of jejunum were clearly visible; but it is conceivable that a jejunal injury could have been missed in a similar case. The danger would be greater if the lesion was incomplete and no large vessels were involved. The effects of the simple crush force will be obvious and may seem sufficiently gross, but the effects of the shearing force must of necessity be excluded by an examination of the upper small-intestine coils.

Summary

A case of severe abdominal crush injury with recovery is described

The mechanism of injury to the structures involved is studied in the light of operative findings.

The value of information on this subject as a guide at operation is indicated.

I wish to thank Brig. Anderson, Consulting Surgeon to the Command, for his helpful advice and criticism both in treatment of the case and in preparation of the report.

Medical Memoranda

A Direct Coagulase Test for Rapid Detection of *Staphylococcus aureus*

Rapid determination of the presence of *Staphylococcus aureus* is often important both for surgical treatment and for the use of penicillin. For practical purposes the organism is as a rule finally identified by the plasma coagulase test. As ordinarily carried out, this involves obtaining a pure 18-hours broth culture of the coccus. But should there be a rich mixed infection considerable difficulty and delay may occur—up to 3 days or more. Mixed cultures in fluid medium or even a pure culture of *Staph. aureus* on solid medium may fail to give a positive reaction. Accordingly, a very simple and reliable quick method has been devised.

Method.—Two or three loopfuls of the suspect material (pus or a purulent blood-clot) are added to a small test-tube containing 0.5 c.cm. of a 4 to 8 times dilution of human plasma (citrate or oxalated) with 0.85% saline and well mixed. If a swab moistened with the material is used, it is well squeezed out by dipping into the diluted plasma and pressing repeatedly against the wall of the tube. The tube is kept at 37° C., and the test is read after 1/2, 1, 6, and 12 hours. A tube of uninoculated plasma serves as a negative control, and another, inoculated with a known *Staph. aureus*, as a positive. Coagulation of the plasma indicates presence of *Staph. aureus*.

Results.—Materials from 72 cases were examined, comprising finger- and toe-pulp infections, suppurating war wounds, and pleural and joint effusions; in 42 of these swabs were submitted. The age of the specimens varied from 2 hours to 4 days. Results have been checked throughout by the ordinary methods, including isolation of pure cultures and their examination for coagulase, etc. In 28 cases no *Staph. aureus* was yielded by any method; in 44 the organism occurred in numbers varying from 3 to innumerable colonies per 4-in. Petri plate. Of the positives, 20 were pure cultures and 24 were mixed with one or more of the following: *B. pyocyaneus*, *B. proteus*, diphtheroids, enterococci, streptococci, sarcinae, micrococci, anthracoids, coliforms, anaerobes. In 42 (95%) the direct coagulase test was positive. The two cases in which the

direct test failed yielded on primary culture a few colonies of *Staph. aureus* with a rich mixture of diphtheroids and enterococci. On the other hand, positive results were got with equally unpromising materials. The quickest positive was obtained in 20 minutes and the slowest after 10 hours. The majority of positive tests were recorded after 4 hours, and those which were negative at this time usually remained so. The presence of other organisms did not prevent a positive reaction except, rarely, where *Staph. aureus* was very scanty. But the early readings must not be omitted, since a coagulum which forms within several hours may liquefy later owing to admixture with proteolytic bacteria. In no instance was there a fallacious positive result in the absence of *Staph. aureus*.

The value of the test is apparent, since direct positive coagulase reactions often develop within several hours—i.e., before ordinary cultural methods can yield a result; also, positives are frequent where *Staph. aureus* is too scanty to be detected microscopically even in several direct smears, or where a mixed infection with various cocci prevents their identification so that repeated plating is necessary before a pure culture is secured.

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Methaemoglobinaemia after Ingestion of Anti-gas Ointment

A review of the literature reveals no record of methaemoglobinaemia resulting from the ingestion of anti-gas ointment. Since we understand that several cases have occurred, some of them fatal, it is thought that the following report may be of general interest.

CASE HISTORY

The patient was a naval rating, aged 24, serving a sentence of detention for desertion. On April 24, 1944, he sustained an injury to the left big toe, and the abrasion was treated with sulphanilamide powder. By May 3 the lesion had completely healed and he was returned to full duty.

On May 25 he reported, complaining of headache, nausea, and vomiting after breakfast; T. 100°, P. 120, R. 18. Apart from a generalized cyanosis, such as commonly occurs with sulphonamide therapy, no abnormal physical signs were found. The condition cleared up in 36 hours and he again returned to duty.

On June 1 he was brought in from parade complaining of nausea, vomiting, and vertigo. Cyanosis was extreme, generalized, and mauve-coloured. There was a generalized flaccidity and marked retardation of the mental processes, inaccessibility, and clouding of the intellect. He replied to questions only after long latent intervals, and not always relevantly. The pupils were moderately dilated and all the reflexes sluggish. The retinal vessels were black and the veins and arteries indistinguishable in colour. T. 97.6°; P. 120—feeble; R. 16—shallow and irregular, with occasional yawning. The heart sounds were faint and there was a tick-tack rhythm. B.P. 110/under 50. As there seemed to be a risk of circulatory failure, and in order that investigations might be carried out, he was removed to hospital.

On admission the above findings were confirmed and a specimen of blood was taken. It was chocolate brown in colour, and spectroscopic examination showed that it contained a high percentage of intracorpuscular methaemoglobin. No sulphaemoglobin was demonstrated. The urine was clear and there was no evidence of abnormal pigments. A blood count showed a moderate leucocytosis of 15,600, with 80% polymorphonuclears; haemoglobin 82%. He was treated with methylene blue 4 gr. orally four-hourly, and apart from a slight pyrexia lasting 12 hours his condition rapidly improved. He was discharged two days later and returned to full duty three days afterwards.

Although a search of the rating's cell was made, no noxious substance was found, but he subsequently confessed that he had taken anti-gas ointment No. 5 on both occasions. He had secreted the ointment in a tube of toothpaste, an examination of which confirmed his statement. He was above the average intelligence, and on questioning gave the following account of his attack. He felt weak, faint, and giddy; his body became anaesthetic, and he did not feel the needle puncture when the blood was taken. Temporary blindness occurred, lasting 1½ hours. Hearing was impaired, and although he could understand questions he could not formulate replies. The vomiting began 45 minutes after taking the substance, and the above symptoms appeared an hour later.

Unfortunately, we are unable to give the nature of the chemical agent causing the methaemoglobinaemia as the ointment is still on the secret list.

Our thanks are due to the Medical Director-General of the Navy for permission to publish this case; to Capt. A. G. Venables, R.N., Commanding Officer of R.N. Detention Quarters, Canterbury; to Dr. H. A. Treble, under whose care the patient was admitted; and to Dr. Magnus Haines and Mr. W. H. Boorman.

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