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THE ELEMENT OF CAUSATION IN ABDOMINAL
CONTUSIONS.*

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There exists a considerable discrepancy of opinion on the question of causation in abdominal bruises; or perhaps, it might be more correct to say, on the precise manner in which disorganization, succeeds the application of force. In order to elucidate this subject several observations have been made, on the bodies of those who have succumbed to traumatisms; and on those who have sustained injury, but have survived, the latter, presenting such a series of symptoms of local disorder and structural disorganization, as in a certain degree at least indicated the physical influences, brought into operation. An effort has been made too, by experimentation in the living dog, to throw further light on the subject; by subjecting him to various degrees of violence, and then, after varying intervals, to kill him, and in dissection, note the succeeding pathological changes.

With this purpose in view, Dr. B. F. Curtis has conducted an extensive series of interesting experiments on forty-four dogs, supplemented by others in six cadavers (*American Journal of the Medical Sciences*, October, 1887). The abdomens were traumatized, by allowing pieces of wood and masses of iron to fall on them. M. Giornadi in the spring of 1879, in Genoa instituted a very extensive series of experiments in the lower-animal, with a similar view. He applied nearly, every conceivable description of force, the animals being in various conditions, and placed in various attitudes. His observations were conducted with rare skill and his conclusions are highly interesting. He left little undone, as far as experimentation went. (*Effets des coups-violents sur l'abdomen. Gaz. des hôpitaux*, Mai, 1879.)

Experimentation on the lower-animal, undoubtedly is not without value, in the domain, of surgery; but, to accept the deductions

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from it alone, and apply them to the human-being without reservation is a great mistake, and calculated to work much evil. In this particular class of cases, the analogy or comparison is not close; and, conclusions reached will accordingly have, but, a very limited range of application, when extended to practical surgery.

The greater number of contusions, or bruises on the abdomen, which we encounter on the human subject, it is quite impossible to induce at all, on the lower-animal; *e. g.*, as falls from great heights, machinery, railroad, accidents, runover-injuries and the like. The law, public sentiment and humane feelings alike demand, that the animal must be anæsthetized; whereby he is unable to avail himself of those auxiliary safeguards, with which he is provided, in the event of sudden accident. The muscles are relaxed and the relation of the organs are in consequence materially altered. Besides, all this, there is little or no analogy in structural composition and arrangement. The quadruped moves in a horizontal position of the body, while the attitude of man, is perpendicular. The entrails of the dog are very thick and tough, and tolerate in a most remarkable degree any description of manipulation regardless of prophylaxis against sepsis. His recuperative powers after trauma are marvelous. His intestine may be removed by the foot or yard, the ends sewed together, and he will scarcely miss a meal, so slight is the constitutional disturbance. His peritonæum, which is nearly as tolerant of handling as his integument, is quite immune against trauma. But, with man, he receives the main impact of force, in full consciousness, and, though his peritoneal cavity is the most exposed to percussive incruising force, it oftener escapes. Nature has made such provisions for its protection, through sudden changes of attitude muscular contraction and the defenses provided by the extremities that serious damage of it, is much less frequent, than of the apparently better protected cranial or thoracic cavities. In a *second's warning*, the muscular girth of the belly sends the floating viscera up, behind the shelving vault of the lower thorax, the chest is inclined and the knees drawn up. Indeed, as a matter of fact, serious nonpenetrating injuries are seldom seen, except, when the body is suddenly caught and fixed, or, one is hit, when off his guard.

The human intestine is very thin and fragile as compared with the dog and its serous-membrane is so exquisitely sensitive and intolerant, that it never can be exposed without danger to life. It is therefore, evident, that in order to pursue an intelligent and practical study of this class of lesions, our observations must be made, rather in the wards of a hospital and the autopsy room, than in a laboratory.

Mortal Concussion of the Abdomen by Blows over the Epigastrium.

A few cases are on record, of instant death following blows over the epigastrium. Ashhurst declared it, as his opinion "that death may follow a severe blow over the abdomen." (*Ashhurst's Surgery*, p. 391.) Mr. Thomas Bryant is unequivocal on this point, and says, that "under certain circumstances, a trifling blow may give rise to alarming symptoms." (Bryant's *System of Surgery* p. 217.) Agnew was reserved on this question. Pirrie believed, that blows over the stomach or duodenum were more dangerous than, on other parts of the abdomen. (*Principles of Surgery*, p. 595.) Le Gros Clark said, "that if the doctrine be true, that a blow over the abdomen may cause death it must be a very rare accident." (*Encyclopædia of Surgery*, p. 988.) Holmes practically repudiated the doctrine. Guthrie believed, that violent blows over the abdomen might lead to ultimate absorption of muscle and gradual relaxation, favoring hernia. (*Guthrie, Surg. Obs.*, p. 312.) Gaut adds his testimony to the probability of blows over the abdomen producing fatal results. (*Science and Principles of Surgery*, vol. i, p. 532.) With a view of determining as fully as possible the recent views of surgeons on abdominal contusions, the current, home and foreign literature, issued, in the past fifteen years was examined, since the time, that laparotomy became a recognized surgical procedure. One of the most conspicuous features of the search, was the comparative scarcity of abdominal contusions, chronicled, during that period; which would imply, that this subject has not received the attention which its importance merits. During that period, I could find no case on record, of sudden death, from a blow over the abdomen, without well-marked pathological alterations succeeding. Modern observation and experimentation all tend to discount and repudiate the assumption that death is commonly possible by a blow anywhere over the abdominal walls, in one of sound health; without structural lesion following. Mortal concussion of the brain and spine are to-day denied by some of our noted authors, and probably, mortal concussion of the abdomen, without central pathological changes has little more to support and perpetuate it, than the parrot-like practice, in vogue, in the past, of servilely quoting from one work to another, notions and opinions which were wanting the stamp of personal observation and had nothing to support them, except their hoary antiquity. Sudden, concentrated violence applied to the abdomen, undoubtedly may cause almost instant death; but, not with the frequency, heretofore supposed. But, cases of sudden death, are on

record, from blows over the cranium, the neck or the thorax. A person is suddenly hit over the abdomen, in a full inspiration, when the lower lobe of the left lung has descended, behind the diaphragm; he gasps for a moment, shock is communicated through the reflexes to the respiratory centers, and for an instant he is unable to breathe.

A similar degree of violence applied over the trachea, the thorax or face, may produce a somewhat similar train of symptoms. The proximity of the solar plexus the præcordia and intimate relations of the terminal filaments of the pneumogastric and sympathetic ganglia, have been supposed to render the epigastric region more susceptible to injury, than others. There are however, but very few well-authenticated cases on record, of immediate death from blows over the abdomen. We never see them occur, as a result of crushes. Some authorities deny that a blow can produce death, unless, the individual is suffering from organic disease, is greatly exhausted or fatigued; as a prize-fighter, toward the close of the contest. No surgeon has ever been an eye-witness to such an accident; therefore it is probable, that those cases on record, were complicated by concomitant pathological conditions; and with them the blow over the stomach is only the fatal climax. Probably, in most instances, the patient in the midst of great excitement, when struck, psychic influences play a dominant part, in paralyzing the heart's action.

*Causation, in Cases of Laceration of Rupture of the Abdominal Viscera
Succeeding Percussive or Crushing Violence.*

The abdominal viscera, in the performance of their functions, do so, in obedience to physical and vital laws, in connection with pneumatics, hydraulics and motion. The integrity of the viscera is preserved, by the harmonious action of these natural forces. A practical knowledge of these, is quite indispensable, for an intelligent comprehension of the mechanical element, in all instances of serious, non-penetrating abdominal injuries. It goes without saying, that a familiarity with the structural anatomy and pathological laws, in operation, here, after injury, is presupposed. In the present instance attention will be chiefly directed to the mechanics of the subject, as an element in ætiology.

For our present purpose, we may regard the abdomen, as a sac, with two openings; one above and one below. Within it are the solid organs, a tubular structure, containing gases, fluids and solids, besides, the great blood trunks and other accessory structures. Its contents are tethered to the spinal-column and diaphragm; and, are

in incessant motion. Its vulnerable areas, are, the anterior, lateral and posterior. The latter is fixed solid and resistant, so that violence, when coming through the lumbar, must, first, spend its energy on the spine.

As a general rule, in abdominal bruises the force comes from before.

This force is of two qualities.

1st. Percussive or contusive ; and, secondly, crushing.

In the majority of cases, the viscera are disorganized by being directly crushed against the bodies of the spinal-column. In the minority, trauma is probably sustained, through percussive force, as by blows kicks or falls. The intestine being a suspended, floating body, when sudden and violent force is applied, it is contused or rent, in proportion to the momentum and volume of force sustained. Nevertheless, abdominal viscera seldom sustain serious harm from blows ; except when they are directed with great energy ; as the kick of a horse ; when the parts are crushed, as well as contused ; and laceration follows, not through the impetus of impact but, through the viscera being directly compressed against the spine or pelvic brim. This is, because, the abdominal walls offer great resistance and the velocity of impact is not ample to disrupture, the mobile, elastic bowel, except, in unusual cases.

A young man came under my care a year ago, who illustrated the *modus operandi* of contusive force on the abdomen. He was running a circular saw, when the board in his hand was suddenly splintered, a large fragment hitting him with great force, over the umbilical region. He died three days later, when an extensive rupture of the jejunum was discovered.

Another case which typifies the same class came under my care, in July, of this year. A large, heavy man was violently kicked, by a young colt, over the abdomen. Collapse promptly set in and he died within six hours ; probably, from internal hæmorrhage. An autopsy was denied. A swimmer, as he plunges into the water, does so, head first ; as he knows from experience, severe shock is likely to be produced, by striking flat on the abdomen.

On the whole, concussive trauma of the abdomen, is more common than compressive, though with few exceptions, the consequences are more trivial.

2ndly. *Crushing Injuries* of the abdomen are always the most severe and yield the largest mortality. One is crushed by some falling body, by the wheels of a vehicle passing over the trunk ; or by being

jammed between two resisting bodies. The mobile abdominal walls anteriorly retract away from the advancing force, until they are arrested, by the vertebral barrier behind. The organs are caught between the opposing surfaces within, and traumatized, in various degrees. In some, in consequence of moderate force the extent of contusion is slight, with no marked constitutional disturbances, while with others, when ponderous bodies have passed over the abdomen, or the extent of compression has been great, a solid organ may be reduced to a pulp, terribly lacerated or contused. The hollow organs, as the intestine and canals suffer variously; from a slight abrasion of its mucous or serous coat, to a complete cleavage through its lumen.

The precise manner, in which various types of visceral injury follows the application of violence over the belly's surface, is not by any means clear. How, indeed, in one case the common, bile duct suffers perforation from pressure, when the muscular-girth, through which that force must be transmitted, the overlying, fragile intestine and the adjacent friable liver, all escape, is quite beyond our comprehension or knowledge.

I have elsewhere, reported a remarkable case, of rupture of the receptaculum chyli—all the other organs (*Medical News*) escaping serious damage. The mesenteric vessels may be opened, the ureter lacerated or nerve-trunks torn in two; and yet the circumjacent viscera escape. And, it certainly is a most remarkable phenomena that deeply lodged organs may bear serious mutilation, and yet, the overlying integuments, are not only, unbroken but not even a mark of discoloration may remain, to mark the site of impact. In no single instance in twenty-five cases of serious abdominal crushes witnessed by myself was there such visible discoloration of the abdominal integument, as in any definite manner, pointed to the probable extent of intramural injury. Perforation of the bowel or damage to the vascular apparatus is produced by, and succeeds, as a result of, the action of such force, as produces various traumatic lesions, elsewhere; and is of two varieties.

1st. *When violence immediately* disorganizes, without the action of secondary pathological changes; as when the intestine is immediately ruptured, a vessel is torn open, or an organ lacerated. In this class, the organ is generally crushed against the spinal bodies, which, in the lumbar-region are powerful and quite immovable. The action brought into operation, is quite the same, as we witness in the chopping of wood. We may regard the descending axe as the vertical plummet, and the rachidian buttress as the block.

Now, if the axe falls with reduced force the stick is merely indented : or if it falls flatwise, it leaves little or no impression.

In ruptures, however force may be applied, its action must be concentrated and over a very limited area. Possibly, tension may play a subsidiary part; but can be little more for, in lacerating the peritonæum the sero-cellular membrane which anchors the intestinal coils to the spinal-column, is an elastic and fragile structure, which is easily torn off, on moderate force.

2ndly. *Consecutive pathological changes* are what chiefly lead to serious organic changes, in those cases of complicated abdominal-injuries.

An organ may be so contused and lacerated, that a considerable area of it is devitalized. A cessation of function in the involved part follows, atrophic changes, wasting or resorption of its cellular elements, ulceration, gangrene or suppuration follows. A hollow viscus or large blood-trunk has borne the brunt of injury. We know, from experimentation, that when an intestine or a large artery is severely contused, its inner and middle coats give way first. With an artery a coagulum at once forms at the seat of injury and there remaining until, the processes of repair are complete, and the circulation will suffer probably, but little or any, as it is maintained, by the collateral branches; but unhappily for the injured intestine there are no communicating branches, to divert the alimentary-current when a local injury is borne by its inclosing walls. Yet, the economy makes provision for this emergency. Function in the whole intestinal tube is immediately arrested. It is placed at once in a quiescent state, and the remarkable plastic property of the peritonæum is called into prompt action, to seal up the impending breach, through adhesive inflammation.

When a main-blood-trunk, like abdominal-aorta is damaged the extremities are threatened. Denonvillier (*Mémoires de chirurgie*, vol. xii, p. 419) has recorded the case of a boy run over by a heavy vehicle. The abdominal symptoms were severe for a few days; and then showed signs of amelioration, when gangrene appeared on both lower-extremities. After death the intima and muscularis were discovered, widely lacerated just above the bifurcation; the lumen was firmly plugged, by a large, partly organized clot. One can understand how the femorals are exposed to crushing force, from below, where they pass over the sharp ridges of the pubes; and, the aorta, where it rises from the left to right, to mount the body of the fourth lumbar vertebra. In spite of the provisions of Nature, perforation of the intestine may follow, at a late date after; when we feel quite assured that all danger is past. In three cases within the past year,

coming under my observation, it suddenly set in, just at a time, when the patients wanted to get up, and when all severe constitutional disturbances were past; in one on the fourth day; in another on the eighth day and another at the end of the third week.

Traumatic peritonitis as a consecutive phenomenon, to non-penetrating injuries of the abdomen is caused, chiefly, in three ways:

1st. The first and most common, is through the direct effects of the injury itself, by contusion; in precisely the same manner as trauma of other serous membrane, which line the great cavities and joints. The peritonæum has been bruised or stretched; its nerves have been over-strained or lacerated and there probably has been such an injury to its vascular branches, as leads to congestion or a sanguineous effusion into its subserous stroma of cellular tissue. We may be warned of its advent by the decubitus of the patients, the parietic intestine and hard, sensitive, abdominal surface. But, inasmuch as the character of the injury which produced it is local, it generally occupies but a limited area, and is often, unattended with severe, systemic disturbances. Intra-peritoneal hæmorrhage is a prolific source of peritoneal inflammation. When the blood leaves its vessels and escapes into any of the tissues, it becomes an irritant; it is a foreign body and provokes inflammation. This we see well illustrated in a sanguineous extravasation, consecutive to injury at the knee joint. We may sometimes, after a severe injury of the abdomen, detect sanguineous fluid in the flanks. Moderate leakage will excite but slight irritation; while a large loss of blood with profound anæmia, can only occur, when there is laceration of a solid organ, or a large blood-trunk. In the latter class, death may occur, before reactionary inflammation of the peritonæum, like that following severe contusion.

Infective-peritonitis succeeds abdominal contusions, as a rule, when there is a considerable breach in some of the hollow or tubular organs. It is generally conceded, that healthy bile, pancreatic juice, chyle or urine, are not a source of infective or serous inflammation, unless, the quantity of escape is very considerable. The most fatal complication, is, when the bowel's wall gives way and the peritonæum becomes infected by intestinal gas or fæces. In all the cases of direct intestinal rupture which I have examined *post-mortem*, there was a very large, associate hæmorrhage. In these cases death occurred, before peritonitis developed. The most dangerous type of traumatic inflammation of the peritonæum comes from consecutive perforation of some part of the intestinal-canal. Its advent is sudden and the

constitutional symptoms alarming,—there is a species of peritoneal-shock.

The appendix is sometimes exposed to pressure as it hangs over the pelvic-brim, in movements of the infant's head, in the parturient act. Probably, the healthy caudal-appendage, because, of its vermicular properties may easily glide out of the way, as the head engages; but, with a preternaturally long, appendix, which has been fixed to the fascia, by previous adhesive inflammation, it is greatly exposed to dangerous compression. Possibly, not a few of those cases set down, as salpingitis on the right side, after labor, are nothing other, than a severe, perforating or non-perforating type of appendicitis.

One such case came under my care this year, succeeding a very difficult labor. From the time of delivery, she complained of a severe pain in the right side; but it was not until the third week, that fulminant symptoms developed. Prompt operation cut them short; when a perforation of the appendix inclosed in a large purulent accumulation was exposed. Another case illustrating the effects of injury, as a causative factor in appendicitis, came under my care lately. The patient a boy, of sixteen was injured by a fall on the right groin. He took the bed with signs of subacute peritonitis was up quite well on the eighth day. At this time he passed from under my care. The next day acute peritonitis set in and he died. On autopsy, there was found a large fæcal extravasation from an opening in the appendix.

Renal Injury.—The kidney suffers trauma through force applied, laterally or posteriorly. It is seldom damaged by vertical force, for the reason, probably, that the intensity of impact is spent, before the organ is reached. A violent blow over the loin or a fall sustained here, is a prolific source of laceration of the organ, with interstitial bleeding which drains off, through the ureter; or we may have an extreme rent with a large accumulation within the capsule. In very severe cases, the capsule itself is torn through, and there is a free escape into the loose, retro-peritoneal tissues. This triple complication followed in a case which terminated mortally, under my care early, this year. The injured man had fallen from the cabin of a drawbridge, striking on the side over an iron rail twenty feet below. He was a very heavy man and fell with great force. In about all our cases of severe contusion over the lumbar spine, we will find evidences of renal complication. Hæmaturia is an early and persistent symptom. It is self-evident that violence over the hypogastrium in

the pregnant, must be attended with danger to the fœtus; and, in any one to the bladder, when it is distended. But, the bladder for an organ which seems so much exposed is very rarely ruptured by force; except, when there is associate fracture of the pelvic bones. It is not infrequently contused and its inner coats lacerated, when transient hæmaturia occurs but a complete rupture is a very rare accident, indeed. It probably escapes by an alteration of its shape, or by sinking into the pelvis, when distended making lodgment for itself, by pushing the perinæum outward. In no other manner can it be explained, how it so generally escapes, while its neighboring organs above are so frequently compromised.

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