LECTURES

ON THE

PRINCIPLES OF SURGICAL DIAGNOSIS:

ESPECIALLY IN RELATION TO SHOCK AND
VISCERAL LESIONS.*Delivered at the Royal College of Surgeons of England.*

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LECTURE VI.

Lesions of Spinal Cord.—Analogy with those of Brain.—Resistance of Spinal Column.—Fracture; Mode of Production.—Dislocation.—Diagnosis of Sprain; Extravasation of Blood; its Varied Position.—Simple Concussion.—Railway Concussion.—Shock.—Morbid Appearances.—Punctured Wounds.—Double Fracture.—Dislocation in Upper Cervical Region.—Complication of Encephalic and Spinal Injury.—Conclusion.

MR. PRESIDENT AND GENTLEMEN,—Whilst the physiology of the spinal cord is, in some respects, more defined than that of the encephalon, the complexity of its functions, as a centre of nerve-force, and as a conductor of that derived from the brain, together with the concentration, so to speak, of those functions within a very limited space at any given point, enhances the difficulties of identifying its special injuries. As surgeons, we generally have to deal with the spinal cord as a whole; the lesions to which it is obnoxious from violence rarely affect it partially, but implicate more or less completely all its texture, and consequently all its functions. Some of these effects are sudden, absolute, and speedily fatal; others are deferred, insidious, prolonged in their endurance, and destructive of health, and ultimately, perhaps, of life. But the pathological condition is the same in each, modified only by the element of time; arrested function from grievous injury in one case, and deteriorated organisation, with its long train of disastrous sequelæ in the other, leading to the same issue.

In some respects there is, as might be expected, a close analogy between the consequences of injury to the spinal cord and those of the brain; whereas, in others, the contrast is remarkable. Both are liable to concussion, to compression, to irritation, to apoplexy, and to organic changes resulting from inflammation; but the consequences of organic lesion, both immediate and remote, differ materially in the two, and are not similarly under the control of surgical treatment. We have seen that extensive lesions of the encephalon may occur without immediate material disturbance of function; nay, that loss of texture is not necessarily a fatal injury; and that, in compression, the removal of the offending cause, as in the uplifting of a depressed fragment of bone, may afford even permanent relief to the sufferer. Not so, however, in spinal injury. In the cord, every segment is, if I may be allowed the expression, a representative of the whole; and violence attended by organic lesion thus produces a concentrated effect, which renders these injuries so little amenable to surgical interference, and so commonly fatal.

In the skull, as in the pelvis, strength, and resistance to the effects of violence are due to solidity and form; in the spine, as in the chest, for obvious reasons, the important element of yielding elasticity is introduced, and constitutes the chief security against harm. It would be difficult to select, even in organic mechanism, a more beautiful exemplification of the adaptation of contrivance to a special and complicated purpose, than is presented by the spinal column; combining, as it does, free mobility with economy of muscular power, and security of the tender organ enclosed within its canal. The mechanism is perfect, and yet the security is not complete; and we here observe, as is still more noticeable in the shoulder-joint, that necessary defects are compensated for in the most admirable way; but that no miracle is wrought to reconcile incompatibilities. In the scapulo-humeral articulation, security against dislocation is important; yet freedom of movement is a still more urgent desideratum; and, consequently, the former is sacrificed to the latter. The bony configuration of the joint, and its lax capsule, afford every facility for free movement, and also for displacement: but this imperfection, as regards safety, is counterbalanced by the mobility of the scapula enabling it to follow the more extended movements of the humerus, and by the attachment, close to the fulcrum, of the rotator muscles. Never-

theless, dislocation of this joint is a common occurrence. And so likewise with the spine; if this long elastic lever is bent beyond its capacity of resistance, it yields and snaps. But, even in these injuries, it evinces the perfection of the arrangement existing for the preservation of its integrity: for it is the arch and body of the vertebra which, as a rule, give way; and dislocation and rupture of the intervertebral substance is the exception to that rule.

I fear that the brief time allotted to these lectures will not allow of my expatiating, at any length, on the various forms of injury to the spinal column: and I am not aware that it would subserve any good end in assisting me to classify the diagnostic indications of injuries to the cord. I may, however, remark that the inferior half of the cervical region, and the lower extremity of the dorsal, are the parts of the column most obnoxious to fracture—a generally admitted fact, I believe, and certainly borne out by my own experience. This is due to several causes: the mobility and relatively small development of the cervical vertebrae, and the horizontal facing of their oblique processes, tend to facilitate fracture and displacement in this part of the column; and the converse obtains in the lumbar region—a development which compensates for the enhanced liability to fracture at that part, dependent upon extended length of leverage. But this source of weakness tells upon the lower dorsal and upper lumbar regions, where the additional security obtained from the lateral support of the ribs is suddenly withdrawn. As regards the comparative immunity of the cord from concussion, no doubt it is in part due to the layer of cerebro-spinal fluid which is interposed between the arachnoid and pia mater; and I believe there is another important source of protection, which, I trust, some investigations in which I am engaged will enable me, at some future time, to demonstrate.

The manner in which fracture of the spinal column is produced, has a more important bearing upon the character of the injury which is sustained by the cord. Direct or indirect violence may break the backbone; but, in my experience, the latter is much more frequent than the former: the application of violence by which the column is bent forcibly forwards, is the most common cause of fracture. I have scarcely ever seen an instance of simple dislocation below the second cervical vertebra, though I have examined many such combined with fracture: indeed, such complication of dislocation and fracture in this region is the type of the majority of cases which have come under my observation.

I believe that my experience in this respect differs from that of some other observers, who have published statistical records of this class of injuries. It is true that the amount of fracture is, in many instances, limited to a thin segment of the body of one of the vertebrae involved, or, it may be, to the edge of the oblique process. But, I repeat that, in the many cases I have examined and have records of, some fracture, be it little or great, has complicated the dislocation in this region, in almost every instance.

In the dorsal and lumbar regions of the spine, simple dislocation is almost a physical impossibility; and rupture of the intervertebral substance, without fracture of the body of one or both of the vertebrae implicated, is of rare occurrence.

The preparation I have on the table is a remarkable example of this

Fracture of Fourth Lumbar Vertebra, with dislocation backwards of Fifth.

form of injury; and its singularity is enhanced by the history which was forwarded with it from the country, when it was sent to the Museum of St. Thomas's Hospital.

It exhibits a fracture of the fourth lumbar vertebra, with complete dislocation backwards of the fifth. The arch of the fourth is broken perpendicularly, and wedged between the spinous and right transverse processes of the third. The fifth is completely severed from its connexion with the fourth, and lies directly behind it, the anterior part of the body of the former being in contact with the posterior part of the body of the latter; the lower border of the fifth does not extend more than a quarter of an inch below the lower border of the fourth.

The patient, a strong man, aged 20, received a blow on the back by the fall of a heavy weight. There was entire paralysis of the lower extremities. At the end of five weeks he had recovered sensation perfectly, and motion partially. He died, exhausted by sloughing of the nates, etc., seven weeks after the accident. His arm and leg had also suffered fracture, and the former had united. Such recovery of function could have occurred only where the lumbar region of the spine was the seat of injury.

Force which tends to produce fracture may, stopping short of that result, severely strain the ligaments of the spine. These cases frequently present themselves in hospital practice, though unfortunately we rarely have the opportunity of watching them beyond the relief of the early symptoms. Most of them recover; but in some few, more enduring mischief results. Local tenderness, defective innervation of the lower extremities, sometimes morbid sensibility combined with loss of power, and general deterioration of health, are symptomatic of the cord itself, or its membranes, being secondarily involved. This condition may be the consequence of violent muscular action, or of sudden twisting of the spine. Thus, I knew it to occur in an engineer, whom I attended with Mr. Pink, of Greenwich, and whose spine was violently twisted in working the engine of a steam frigate: he was unable to walk, and complained "of severe pain in the lumbar region, and of acute tenderness at one spot. The pain extended down the right lower extremity, which was partially paralysed. After local depletion and protracted rest, he recovered; but six months elapsed before he was well. Another instance occurred in an acrobat, one of whose feats was to bend himself backwards in a most unnatural way. The same result is met with in some cases of violent concussion in railway accidents. The symptoms I have enumerated are not, however, to be regarded as necessarily implying irrecoverable organic change, or any change at all in the cord; the mischief may be purely meningeal in its nature. I may refer to a very common early concomitant of these injuries, viz.: hæmorrhage from the bladder, as suggesting that the kidney is the seat of inflammation and the source of suffering. I am satisfied, from repeated observation, that such is not the case. No doubt the blood is derived from the kidney, which suffered from compression; but, of the many cases I have witnessed, I have never had reason to suspect that nephritis or organic disease followed.

Extravasation of blood within the theca vertebralis may occur without fracture; but such instances, affording an opportunity of verifying the actual condition, are rare. I have a memorandum of a remarkable case of this kind, which was narrated to me but which I did not see. A man was struck violently on the back with a chain-cable; there were no immediate symptoms of spinal injury, but a paraplegic condition soon supervened, and extending rapidly upwards, destroying life by asphyxia. The theca was found distended with fluid blood, derived from a ruptured spinal artery. Paraplegia, supervening after an injury to the spine, is suggestive of hæmorrhage; and probably, in many instances, the protracted character of the symptoms, indicating concussion of the cord, may be due, as in the brain, to the presence of extravasated blood, which is slowly absorbed. But I am not prepared to say that the symptoms of pressure, in fracture of the spine, are usually in any degree due to extravasation of blood, either external to or within the substance of the cord. I am inclined to think not; although the red appearance, occasionally seen on section of a recently injured cord, is suggestive of the presence of effused blood, rather than of the consequences of inflammation. Certainly I have seen instances of fracture unattended by primary, or indeed any, symptoms of the cord being implicated. I have a record of several cases in which depression, mobility, and crepitus had indicated that there was fracture of the spinous process or arch of one or more vertebrae; and yet the patients have recovered without harm being done to the cord.

The following case may serve to exemplify this condition. A porter was knocked down by a cab, the wheel of which, he thinks, struck his back. He could walk, but with difficulty. His chest was contused, and he was suffering from general symptoms of shock; but there was no paraplegia, nor other symptom of injury to the spinal cord. The spinous processes of two of the upper dorsal vertebrae were freely moveable, and crepitus was distinct. This patient made a good recovery. Instances of this class are not very rare; and the injury is generally the consequence of violence directly applied to the spine.

In one case under my care, seven or eight years since, the injury was still more severe; in fact, the nature of the lesion associated with its consequences is, in my experience, unique. A painter had fallen from a ladder, thirty feet high, and was impaled on some spiked area railings. One spike entered the lumbar mass of muscles, just above the sacrum; another entered the gluteal region. There was no indication whatever of any visceral or spinal injury. He had a violent rigor on the fourteenth day, and died on the sixteenth. On examination there was found to be a transverse fracture through the lower part of the second dorsal vertebra; and pus burrowed from this spot beneath the pleura, forming a bulging swelling there; but there was no displacement, the anterior and posterior ligaments being entire. The spinal cord was softened, and showed, under the microscope, exudation corpuscles and other inflammatory products. The softening extended in both directions, but more upwards, and was more apparent in the anterior than in the posterior columns.

I have notes of another case, resembling the preceding in the mode in which the injury was inflicted, the patient being impaled by falling, with his abdomen downwards, on some spikes. He survived forty-eight hours; and, on examination after death, the extremity of one of the spikes, which had entered near the umbilicus, was found lying across the rectum. The centre of the body of the second lumbar vertebra bore an indentation, corresponding to the point of the spike which had been thus broken off, yet this patient had no spinal symptoms.

Simple Concussion of the spine occurs as the consequence, usually, of a fall on the nates or back. I say concussion, because the analogy in the symptoms which characterise this condition and so-called concussion of the brain, justifies the use of the expression.

The shock in spinal concussion is not, generally, severe, even when the paraplegic condition is well-marked. The existence of this injury is determined principally, as in concussion of the brain, by negative evidence. The absence of local signs which indicate fracture, the mode in which the injury was produced, and the amount of violence applied, rendering it improbable that the spine is broken, is the negative evidence to which I refer. Yet, in some cases, where the symptoms are persistent, doubt must remain as to the true nature of the lesion, and a cautious prognosis is, therefore, required.

One of the earliest cases which I remember, as well as one of the best marked, occurred to a gentleman who was thrown from his gig, and was landed, in the sitting posture, on a heap of stones by the road-side. The general symptoms of shock were not severe, and the patient's health did not seriously suffer; but he was entirely paraplegic for a time, and did not quite recover until after the lapse of some months.

As the diagnostic indications of this injury are well exemplified in the following instance, I will give the details of the case, which occurred in my hospital practice about two years since. The patient, a man thirty-six years of age, weighing 11½ stones, gave the following account of himself. He was tripped up in the road, and fell heavily on his left hip, and then turned over on his back. On trying to rise he failed, not having any power of movement in either lower extremity. He was at once brought to the hospital. On admittance, he complained of pain in the lumbar region, and there was slight tenderness on pressing the spinous ridge of this part; but careful examination failed to detect any irregularity or other sign of mechanical injury of the vertebral column. There was entire loss of power in his lower limbs; he could not even move a toe; sensation was impaired; he said his legs were numbed. There was slight priapism, and he was unable to micturate. His pulse was 60, but there were no signs of well-marked collapse. On the third day he was able to move his toes a little. On the ninth day sensation was perfect, but he had made very little progress in regaining muscular power. Nearly three weeks elapsed before he was able to dispense with the catheter; and at the expiration of five weeks he was still almost as helpless in moving any part of his lower extremities. He remained in the hospital for four months, his health being tolerably good throughout. He was then able to get about very fairly, but with a shuffling unsteady gait. I have not given any account of the treatment, as it is unnecessary to my purpose. It consisted in rest, which indeed was compulsory, and attention to the bladder and the general health. I have no memorandum of the condition of the urine, which I believe was healthy.

The causative accident in this instance was slight, too trivial to produce fracture, and the symptoms were not those of sprain. There were no physical signs of displacement; yet, the paraplegia was marked; but not including corresponding loss of sensation, which would have been present if a displaced vertebra had pressed on the cord. The slow recovery was a gradual confirmation of the diagnosis, that fracture with displacement was not the injury to which the symptoms were due.

Yet, I must admit I cannot dismiss from my mind the impression that, in these and similar protracted cases, there is something more than simple

concussion needed to account for the duration of the symptoms; probably extravasation of blood into the theca or canal, which was slowly absorbed. I do not think that the unequal effects produced on the several columns of motion and sensation forbid this supposition, for this effect is by no means uncommon, being usually in favour of sensation, where the inequality is noticed, and indicating that the anterior half of the cord, and part of the lateral columns, are the parts implicated. A child, $3\frac{1}{2}$ years old, was admitted under my care, who had been run over by a heavy sand-cart, sixteen days previously; the wheel passed over the loins. There was nothing particular noticed at the time, except her inability to walk as well as usual. This disability increased, and, when seen by me, she could scarcely manage, when held up, to shuffle her feet along. She complained of no pain, had no difficulty in passing her water, and the sensibility of the legs seemed to be in no degree impaired. On careful examination there was nothing abnormal to be observed in any part of the spine. The treatment consisted in rest, and friction of the back with liniment of ammonia. She remained in the hospital five weeks, and then left quite well.

A remarkable case was mentioned to me by the late Dr. Dyer, who acted for the Brighton Railway Company. A man was injured in a collision in the tunnel, four or five miles from Brighton. He walked this distance with some difficulty into the town; and within twenty hours became entirely paraplegic. He recovered slowly; and after a lapse of two years was able to walk as well as before the accident. One spot on the back was always tender, and continued so still at times. The analogy between this case and a similar but fatal injury which I have already mentioned, seems to point to hæmorrhage as the probable cause of the protracted symptoms.

In the category which I am now considering a class must be included, which have assumed an adventitious importance, in consequence of the claims of the sufferers to pecuniary compensation for injury received in railway travelling. Although I have seen many such cases, especially when acting on behalf of one of the railway companies, I am free to admit that the multiplication of my notes respecting the various complaints of the patients, has by no means simplified the classification of their ailments, nor facilitated the reduction of their symptoms into such a code as may claim to be justly regarded as diagnostic of this special form of concussion. I speak of it as special, because there certainly are distinctive characteristics attending railway concussion of the spine, which are exceptional, to say the least, in a similar injury otherwise produced. And this exceptional character consists in the curiously diversified results which are met with; sequences which seem to be more allied with general nervous shock, and consequent deteriorated innervation, than upon special shocks or concussion of the spinal cord. Indeed, it is difficult to explain many of the sequelæ of these injuries without supposing that the organic nerves, and therefore functions, are seriously implicated; that the excretory functions are imperfectly performed; that the organic chemistry is deranged; and that the source of life, the blood, is poisoned.

Again, as in hysteria, obstacles beset the surgeon in his honest effort to disentangle the confused web of symptoms, by the admixture of that which is real with that which is imaginary, exaggerated or assumed. The motive for exaggeration is sufficiently strong to induce self-deception, and therefore to raise sceptical surmises in the mind of the surgeon. I have no doubt that mental shock acts an important part in aggravating many, and even in inducing some, of these symptoms; and it is impossible to ignore the fact that the mischief, demonstrated by even physical signs, extends to the encephalon, as in loss of co-ordinating influence over the muscles; or, again, in deterioration of mental power, or of some particular faculty, such as memory or readiness of expression. In some instances the shock is received especially on the spine, as when the sufferer is sitting with his back so placed as to experience in this part the violence of the concussion. When this is the case, the symptoms are usually immediate and decisive, and assume very much the character of spinal shock from other causes. Yet, even in these instances, I have observed that, very often, the sequelæ are more varied and protracted than in ordinary concussion; a circumstance which is probably explained, in a measure, by the influence of emotion; as I think I have noticed it more frequently in women than in men. But in some of the most aggravated cases I have encountered, this direct injury has not been noticed, and could not have occurred, from the position of the sufferer at the time of the accident.

Concussion from a blow on the back is not always immediately followed by spinal symptoms, as is shown in a case which was under my care about four years since. A wheelwright had been knocked down by a severe blow with the fist on the upper dorsal region. There was considerable shock produced; and in some thirty-six hours afterwards he began to complain of pain extending downwards from the point where he was struck; and partial paralysis of both arms gradually supervened, at-

tended by diminished sensibility; the lower extremities retained their natural state. The patient quitted the hospital, at his own request, whilst still very helpless.

In another case, reported in one of my clinical lectures, a young sailor was thrown violently down by catching hold of the revolving wheel of a carriage which struck him. When brought to the hospital, he made light of his injury, and complained only of a little tenderness on percussion over the upper dorsal region. His breathing was peculiar, a long inspiration followed by a rapid expiration. He soon after vomited; and, during the night, had a succession of epileptiform fits, attended by violent emprosthotonos and unconsciousness. He had never had a fit before. Yet, in the course of a few days he expressed himself as feeling quite recovered, and requested to be dismissed.

I have referred to these cases as presenting some features allied to the consequences of railway injury; and yet others in marked contrast with each other. The age of the former patient was sixty-four; that of the latter, twenty-two; an important element in its influence on the sequelæ of these injuries.

In order to exemplify what I have been saying respecting this class of railway injuries, I will enumerate the principal symptoms I have observed in the instances which have come under my notice, and make a few remarks on them. I think this will be preferable to occupying your time by the detail of particular cases. Spinal concussion may be immediate and well-marked; or the indications of spinal mischief may not supervene until after the lapse of some time. General shock is often, but not always, in excess of that which accompanies simple concussion; in some instances the collapse is great, accompanied by insensibility, but without evidence of injury to the head. Reaction, under such circumstances, is tardy and irregular. Numbness and tingling, sometimes local, sometimes universal, is complained of. Other symptoms are, rigor, continued sickness, intermittent fits of numbness, excito-motor spasm in the limbs, violent throbbing sensations, or sense of heat or cold in the head or other parts, want of sleep or continued drowsiness, confusion of intellect, enfeebled muscular power, deafness, defective sight accompanied by ocular spectra, hyperæsthesia in some parts, but especially in the spine; great emotional excitability. Besides these I could enumerate other more especial symptoms; but they have been peculiar to isolated cases. With rare exception, extreme sensitiveness of the spine is present in these cases, and more frequently located at some particular part, than distributed over the whole column. Again, this pain on pressure is sometimes referred to the lumbar muscles, at others to the spinous ridge. In some of these cases the patients entirely recover after a longer or shorter interval; in others, the health is permanently enfeebled, and a life of protracted discomfort is entailed; or the sufferer sinks, emaciated and exhausted, into a premature grave; or becomes the victim of some acute disease, the destructive tendency of which his defective organism is incapable of resisting.

It will be perceived that many of the foregoing symptoms and signs may be referred to what we are accustomed to regard as concussion of the spine, but many also are due to general rather than special nervous shock. In some instances there is probably meningeal mischief; but the indications in others clearly point to organic change in the cerebro-spinal centre.

I have already shown, in a preceding lecture, how powerful an influence emotional shock or physical concussion may exercise on organic vitality; and I think it not inconsistent with acknowledged facts, to affirm that protracted functional disturbance, or even fatal disease, may be the consequence of a rude shock, simultaneously, to the nerve-centres of the emotions, of organic and of animal life. I am, therefore, disposed to regard these cases of so-called railway spinal concussion as, generally, instances of universal nervous shock, rather than of special injury to the spinal cord. At the same time, I admit that in this class of cases we meet with instances of simple concussion, but I see no reason for taking them out of the category of concussion of the spine from other causes.

I will close these remarks by narrating the history and *post mortem* appearances of a fatal case of injury to the spine, where no fracture occurred; and also the microscopic appearance presented in a case which was examined by my friend, Mr. Lockhart Clarke, who has kindly supplied me with a drawing, from which the accompanying diagram has been made, of the affected part.

A female child $2\frac{1}{2}$ years old, was admitted into the hospital, under my care, in October 1866, having been thrown down in the street by a passing cart, the wheel of which went over the abdomen. The child was unable to walk, but moved her legs and did not seem to be seriously hurt; sensation did not appear to be impaired. The bladder retained its contents, and catheterism was required. The feebleness of the lower limbs increased; and in the course of a few days, the paraplegic condition was complete, including entire loss of sensation in the

lower extremities. The child survived rather more than three months, varying as regards her general health; and usually dull and indifferent to all around her, with occasional transient fits of animation. At the autopsy, the bladder was found thickened; there were inflammatory deposits in the lungs; and the veins in the lower half of the abdomen and spinal canal were much congested. There was no fracture nor displacement of vertebrae; the membranes were healthy, although there was a considerable quantity of fluid in the lower half of the arachnoid space. Opposite to the eighth dorsal vertebra, the normal size and healthy appearance of the cord suddenly ceased; and below this point, nothing was left but a string of soft atrophied nerve-matter. On cutting into it at different parts, there was no trace of hæmorrhage anywhere, and the investing membranes were in no way diseased. When examined microscopically, the cord was found to contain inflammation corpuscles, for about three-quarters of an inch above the point of apparent distinction between the healthy and diseased cord; and in the lower part they were extremely numerous and of large size, but there was no trace of blood.

What might have been the proximate cause of this injury to the cord it is difficult to say. The most probable surmise is, that blood was extravasated; and yet I failed to discover any trace of it within or around the cord. The microscopic condition of the affected portion of the cord enables me to say with more certainty that inflammation, softening and disintegration preceded the atrophic state of its extremity; a change very closely allied to that which is witnessed after mechanical lesion of the same part.

The case of Mr. Lockhart Clarke to which I alluded, is published in the Transactions of the Pathological Society for 1866. It is, I believe, the first instance in which the peculiar degeneration in these special injuries has been described and figured; I venture, therefore, to give an abstract of the symptoms and microscopic appearances.

The gentleman from whom the spinal cord was taken, had been the subject of a railway injury 3½ years before his death. His health and physical power gradually failed, leaving his intellect unaffected; his gait became unsteady, somewhat like partial intoxication, but without jerking or twitching; and his speech had latterly become thick and hesitating. The cortical substance of the brain was found generally pallid and soft, particularly on the under surface of both anterior lobes. The spinal cord was generally wasted and shrunken, this change chiefly depending upon a diminution of the antero-posterior diameter, which, in many places, was not more than equal to half the transverse. This was especially the case in the upper portion of the cervical enlargement. On making sections, it was found that, of all the *white* columns, the posterior were exclusively the seat of disease, being darker and more opaque and dense than the antero-lateral. When examined, both transversely and longitudinally, under the microscope, this appearance was found to be due to the presence of a multitude of compound granular corpuscles and isolate granules, and to an exuberance of wavy fibrous tissue replacing the obliterated nerve-fibres. The posterior horns, at their extremities, contained an abundance of isolated granules, and the anterior cornua were smaller than natural. This patient had suffered no fracture, wound, nor material contusion, but simply from the shock consequent on the collision. (See Figs. 1 and 2.)

There is a close resemblance between this condition of the cord, and that which is described by a recent author* as obtaining in simple locomotor ataxy, not dependent on injury, where the morbid changes are limited, with rare exception, to the lumbosacral region. In this condition, the posterior columns of the cord and the posterior roots of the spinal nerves are found diseased, the morbid appearances consisting sometimes in grey degeneration, or in a gelatiniform or translucent condition, with a diminution of consistency, or in induration (sclerosis). In some instances the posterior cornu of the grey matter is involved. The diseased structure presents oil-globules, and is made up of atrophied and degenerated nerve-tissue, connective tissue in excess, and amorphous granular matter.

Of bruising or crushing of the cord, in fracture or dislocation of the spine, it is necessary I should say but little; the experience of hospital surgeons scarcely varies, I apprehend, in regard to the diagnostic characters by which these injuries are identified. It is true that the consequences of pressure may be present without fracture, and obscurity may thus attend a case, in which the local physical signs are doubtful or cannot be detected. But, with rare exceptions, the nature of the accident, immediate and well-defined paraplegia, including the bladder, early priapism as a consequence of spinal irritation, subsequent alkaline changes in the urine, due, probably in a measure, to the same cause, leave no doubt, even when the local signs are not clearly marked, that fracture with compression of the cord exists. The subsequent progress

of the case confirms the diagnosis; and in fatal instances the extension of inflammatory softening deprives fresh parts of the trunk and limbs of power of motion and sensibility, until the chief centre of respiration is reached, when the patient dies asphyxiated, if he do not succumb at an earlier period to exhaustion or some organic complication. Yet, there are exceptional cases; and as I have pointed out that fracture of the processes, arch, or even the body of a vertebra, does not necessarily imply such displacement as will compress the cord, so, on the other hand, complete paraplegia after injury may exist without fracture; but whether

Fig. 1.—Transverse section of human spinal cord through upper third of cervical enlargement, from a case of injury in railway collision. Cord very much flattened from before backwards, as seen in comparison with a corresponding section (Fig. 2) from a healthy cord.

A A'. Antero-lateral column of left side. B B'. Outer and inner portions of posterior column. C. Gelatinous substance of posterior gray horn. D. Anterior gray substance or horn. E. Anterior median fissure. F. Commissures between the lateral halves of the gray substance, containing the oval canal. The antero-posterior flattening is due to atrophy of the posterior columns. The dark dots represent the cut ends of longitudinal nerve-fibres, which are scanty in the intervening space between B and C, and have nearly disappeared in the inner division, B', of the posterior column.

persistently so without compression or mechanical lesion I am not prepared to say. In other exceptional cases, in which paralysis of voluntary movement and the loss of sensibility are incomplete or disproportioned, or reflex action is increased, we may associate these peculiarities with lesion of particular parts of the cord. Thus, as I have already remarked, complete suspension of voluntary motion and diminished sensibility indicate lesion of the anterior half of the cord, including the grey matter and part of the lateral columns; whereas, partial loss of voluntary movement, and complete or nearly complete loss of sensibility, accompanied by heightened reflex activity in parts receiving their supply of nerves from below the seat of injury, may be associated with lesions of the posterior columns and the grey matter, in any limited part of the cord. But when the same columns are deeply affected for at least two or three inches, the anæsthesia is accompanied by the loss of muscular co-ordination in the limbs; which, together with acute shifting pains and other symptoms, constitute locomotor ataxy.

But, as I have remarked, it very rarely falls to the lot of the surgeon to witness these symptoms as the consequence of mechanical lesion, and still more rarely to verify them by *post mortem* examination. The phenomena of reflex action are most commonly noticed, in association with paralysis, whether the lesion be in the anterior, posterior, or lateral

* Dr. Radcliffe, in Reynolds's *System of Medicine*.

column. No definite conclusion can, therefore, be drawn from this circumstance, beyond the fact that the cord is the seat of lesion. Relaxation of the sphincters is often enumerated among the signs of spinal compression, or functional deterioration of the cord from other causes. I believe this is an error; the reflex action of these annular muscles is stimulated, when the source of their innervation is not directly implicated, in common with that of other muscles; but the voluntary power which in health, may be and often is exercised over these muscles, is suspended; and, as I have already explained, the reflex action alone is insufficient to resist the expulsive power of the intestine.

A case which has been recently under my notice illustrates this condition. The patient, an elderly man, is weak in the lower limbs, and there is defective co-ordinating power, especially apparent on any fatigue being incurred. He is rarely able to evacuate the bladder, even partially; but habitually uses a catheter for the purpose. Under ordinary circumstances the reflex power of the sphincter is sufficient for the retention of the contents of the bowel; but if there be any disposition to relaxed bowels, or if the peristaltic movement be stimulated by medicine, he is quite incapable, by any exercise of volition, to resist the expulsive force, although he is conscious of the necessity of making the effort.

The period of survival in fatal traumatic lesions of the spine bears, *ceteris paribus*, a direct proportion to the interval between the chief respiratory centre and the seat of injury. The general condition of the patient frequently, I may almost say usually, is not characterised by any corresponding depression or downward tendency; and it would be an error to augur favourably of the issue because the intellect is clear and active, and the organic functions are healthily performed. Vivid dreaming, though not necessarily of a distressing character, I have noticed as a frequent symptom towards the close of life. The steady extension of paraplegia upwards is a sure measure of the progress of the mischief, and an indication of its impending fatal result.

Penetrating wounds of the cord, without compression, are rare in my experience, and I am tempted to quote the following interesting case, as exemplifying this form of injury and the attendant symptoms, together with some accidental concomitants which are met with in lesions of the cord.

A labourer, aged 24, was engaged in working in a tunnel near Sydenham, when a large mass of earth fell upon him, throwing him on his side, and doubling his legs up under his body, so that his toes were almost forced into his mouth. When lifted up, his lower extremities were paralysed and insensible, but he was conscious and collected. When admitted into the hospital he was in a state of collapse, and complained of pain in the back and crest of the ilium; extravasation, extending from the latter spot along the lumbar spine, prevented me from ascertaining, by such manipulation as was justifiable, whether the signs of fracture were present. The bladder was paralysed. In the evening he had slight sensation when pinched in the thighs. On the following day there was moderate reaction, and slight sensibility in the lower limbs. On the fifth day the urine became ammoniacal; on the sixth day there was blood mixed with the mucus in the urine; and he complained of pain in the hypogastric and iliac regions. On the ninth day he could feel as low as the knees; the urine continued bloody. On the eleventh day, sensation had extended still lower, and there was evidently an expulsive effort made when the catheter was partly introduced, as the urine escaped in considerable quantity, if it was then withdrawn. On the thirteenth day he complained of a peculiar sensation of numbness all over him, and of fluttering at his chest and rising in his throat. When pinched in the upper extremities, he could only just feel it; but he could move and make use of his arms and hands. His pulse was very rapid. Some brandy revived him. On the following, the fourteenth day, he was seized with a similar paroxysm. The muscles of the upper extremities were at intervals in a state of violent spasm; his face was expressive of extreme anxiety, and he rolled his head violently from side to side. He complained of an inward consciousness of loss of sensation, and earnestly asked those around him when this feeling of an impending fit would pass off. There were intervals of rest. His heart beat with excessive violence and rapidity; and on listening to it a peculiar ringing sound was audible at its base. The respiration was hurried, but unaccompanied by mucous râle. He expired quietly on the following morning, without dyspnoea supervening.

On examination, the brain was found healthy. In the spine, the left transverse processes of the first, second, and fourth lumbar vertebrae were fractured. The bodies of the last dorsal and first lumbar were broken through obliquely, from the right side downwards. There was scarcely any displacement visible from the front, but there were spicula of bone projecting backwards from the fracture into the spinal canal; and opposite to these was a small wound penetrating the dura mater, from which a small quantity of nerve-pulp protruded. On laying

open the theca, the substance of the cord appeared to be very much softened in this situation, and there was a less degree of softening for three or four inches upwards; the pia mater covering this portion was injected. A little blood was effused beneath the pia mater at the seat of injury. Microscopic examination of the softened portion of the cord exhibited numerous aggregations of compound granule cells, some of which were seen in the upper portion of the cord, above the seat of softening. The pelvis of either kidney was inflamed, and there was a patch of lymph in the left.

Double fracture of the spine is occasionally met with; but, in my experience, this is a rare occurrence, where there is a wide interval between the injuries. It is most likely to occur, where the force producing the fracture continues to operate, or has not fully expended itself by breaking the spine at one point. The symptoms would be referred to the upper injury, supposing that the cord is compressed at each fracture. I have notes of a case of this kind, in which a young woman was crushed by a falling woolpack. She survived for some days, and the *post mortem* examination showed a comminuted fracture, with compression of the cord at the first lumbar vertebra. The second fracture was also comminuted and involved both the arch and body of the second dorsal vertebra, but without such displacement as to compress the cord; yet the texture of the cord at this spot was discoloured on the surface, and presented a diffused clot in its interior. The young woman's symptoms were somewhat peculiar, and indicated that the primary and more severe mischief was at the upper lumbar fracture. She had no sensation, properly speaking, below the *mammæ*, for she was not conscious when she was touched or pinched; yet she said that her feet felt swollen as if they would burst, and she had tingling sensations, as of the presence of pins and needles, in the lower extremities. The muscles of the legs could be excited to action by tickling, and she was conscious when her bladder was distended, though she could not evacuate it.

Of simple dislocation in the upper cervical region, death is the immediate consequence. The following case of traumatic disease thus terminating is an interesting instance in point, and will serve to exemplify the condition of the patient as the disease progressed.

A warehouseman, aged 45, was admitted under my care in 1864. His history was that sixteen months previously he was knocked down by a horse, and fell on his head, which was cut, and his back was bruised. He was stunned for a time, but soon returned to his work, though unable to rotate his head for two days. Five months afterwards his health began to fail, and prominence of the spine with pain in the dorsal region followed; he was unable then to rotate his head, except to a limited extent. This last symptom was intermittent—that is, he described the movement to be entirely suspended for a time, and then the bones suddenly slipped into their places, and free movement was restored; the apparent slipping out of position was as sudden. The intervals during which he enjoyed free movement extended usually to several weeks. When admitted, he could walk, and the sensibility of the lower part of the trunk and extremities, and command of the bladder, were natural. The head was fixed; the axis was very prominent, and the atlas seemed to have slipped forward; the lower dorsal spines were prominent and tender. A few days after his admission, he was seized with sudden dyspnoea and paralysis, and soon expired.

Autopsy.—There was caries in the dorsal region of the spine. The odontoid process of the axis was seen close to the posterior margin of the occipital foramen, its surface being carious and denuded of ligaments; the transverse ligament of the atlas had also disappeared. The upper extremity of the spinal cord appeared quite crushed and pulpy, and the lower portion of the medulla oblongata was also soft. The brain and its membranes were healthy; but much cheesy matter was found in the dorsal part of the vertebral canal, in front of the dura mater.

The condition of this patient, as described by himself, clearly indicated the state of the cervical vertebrae, as verified by dissection; yet his description could scarcely be credited, on account of its improbability. The explanation probably is, that the moderator ligaments remained to support the relations of the atlas and axis, after the transverse ligament had given way by ulceration; or the converse might have been the case. There was no effort at repair by ankylosis.

As an illustration of the obscurity sometimes attending the diagnosis of injuries of the head and spine, and of the importance of giving a cautious prognosis, I will quote this final case which was recently under my care in the hospital, of the grave and complicated nature of which I was unsuspecting during the time that the patient survived.

A married woman, aged 58, was admitted in June 1865. She had been thrown from a cart and fell on her face; but her husband, who was with her, thinks that the wheel did not pass over her. When brought to the hospital, she was much agitated, and complained most of pain

and stiffness in her neck, and of her jaw. The lower jaw was fractured in two places; and there was a diffused swelling on the right side of the neck, extending below the clavicle. The slightest movement of the head occasioned pain in the neck. The left ear was much torn, and the face was lacerated in several places. The injury of the jaw was attended to, and an ice-bag was applied to the neck. She passed a restless night, and complained of a sense of suffocation when the jaw-bandages were tightened; otherwise she seemed as well as could be expected, considering the nature of her injury, as far as it was apparent. On the second morning, the cervical swelling had much subsided, and she expressed herself as feeling better, and imprudently sat up, outside her bed, to wash herself. After returning to bed, and whilst sitting up, her face suddenly became livid, and she fell back dead. Besides the injuries enumerated, the *post mortem* examination revealed the following lesions. The brain was very soft, and there was bruising of the inferior surface of the anterior lobes of the cerebrum, with slight extravasation of blood extending as far as the white substance. There was a fissure in the skull, passing through the left side of the cribriform plate of the ethmoid, and reaching back to the optic foramen. There was some blood effused between the dura mater and the left cerebellar fossa of the occiput; and there was a fracture in the same situation, extending into the left jugular fossa. The spinous process of the sixth and seventh vertebrae were broken off, and there was abnormal mobility between the axis and third cervical. On their removal, it was found that the connecting ligaments and intervertebral fibro-cartilage were ruptured, so as to allow of considerable movement of the second vertebra forwards on the third, but of very limited movement backwards. The upper part of the spinal cord was crushed; but the second and third vertebrae were not broken.

This case is remarkable for the entire absence of cerebral symptoms, such as might have been expected as a consequence of the injury to the skull and brain; and also for the fact that the spinal displacement did not occur earlier. That this complicated mischief was the result of the fall rests on the assertion of the patient's husband; but the external contusion seems to be suggestive that the wheel of the vehicle had passed over the neck. The interest of the case is enhanced by the fact that the rupture of the intervertebral substance was unaccompanied by fracture of either of the cervical vertebrae implicated—a circumstance which would have been scarcely possible in any other region of the spine, and is of very rare occurrence even in the cervical.

In the preceding remarks, I have kept in view the relation of shock to the various injuries which we have been considering. In other visceral lesions, especially those of the abdomen, the symptoms of shock are more sharply defined than where they are complicated with injury to the cerebro-spinal nerve-centre. In shock, the appeal is specially and directly made to the cyclo-ganglionic system of nerves, and organic life is primarily affected; the functions of animal life are involved secondarily and by sympathy. In lesions of the brain and spinal cord, this order of phenomena is inverted.

I have often been struck with the limited amount of shock which, as a rule, accompanies even severe lesions of the cerebro-spinal centre; whereas, in structural injury of other viscera, especially of the membranous organs of the abdomen, the shock is immediate and fully pronounced. The evident explanation of this contrast is, that the abdominal membranous viscera are largely supplied by the cyclo-ganglionic nerves, and that the ganglia themselves are implicated, more or less, in the hurt, even where mechanical violence is unattended by textural lesion.

I had still much to say, had the time permitted, on some other lesions of the cord, including tetanus; and I feel that even this short sketch, imperfect as it is, is rendered still more incomplete by the omission of some comments on operative interference in fracture of the spine. I entertain an opinion decidedly adverse to any such proceeding; but I feel it would be impracticable for me to represent fully my reasons for this opinion, at the same time that I do justice to the arguments which have been urged in favour of operating, without extending this lecture beyond the prescribed limits; I am compelled, therefore, reluctantly to acquiesce in this omission, and also to relinquish my original design of including in the present course other visceral lesions, which abound with elements for illustration in their many and varied phases.

If the confidence of the Council should be extended to me during another season, and I am spared to realise my wish, I may hope to complete the present division of my subject; and also to place before you, in a collected form, the results of my experience in other visceral lesions in association with shock.

I feel that the value of the remarks I have thrown together in the preceding lectures, bears no proportion to the importance of the subject, or, I may add, to my own anxious desire to do justice to it in such limited space, and in the time which has been at my disposal to collect and arrange my materials. Respecting these materials I may say one parting word.

My illustrations, in nearly every instance simply typical of the class to which they belong, have been drawn exclusively, or almost so, from my own cases. Yet, I trust it may not be inferred that, in so making my selection, I have been unobservant of the vast store of facts which have been within my reach, in the practice of my colleagues, during the quarter of a century that I have been on the surgical staff of St. Thomas's Hospital, nor unmindful of the labours of others in the same field of scientific surgery. Had I been so negligent, I should indeed have done violence to my own sense of duty, and have been heedless of becoming modesty in my endeavour to fulfil it; at the same time I should have negatived those principles which I sought to establish in commencing this course. I may venture to claim that the opinions enunciated have not been hastily formed; and the records of the cases, by which I have exemplified and supported these opinions, may possibly be regarded as possessing the merit, *quantum valeat*, of being an impartial chronicle of my professional experience.

To my colleagues on the Council, and to the visitors who have honoured me, I beg to offer my acknowledgments for the compliment which is embodied in their attendance at these lectures; and especially I thank you, Mr. President, for the encouragement your presence has afforded to me,—an attention which I the more appreciate, as I cannot but be aware that the claims upon your time are such as might reasonably have excused you for absenting yourself from the chair on these occasions. Amongst my auditors I have recognised some of my former pupils. This testimony of their regard is a gratifying assurance to me that the time we have spent together in the lecture and dissecting rooms, and in the hospital wards, is not without its agreeable reminiscences to them; whilst it has left to me the valued heritage of many an enduring friendship.

NOTES ON CRANIAL MALFORMATIONS.

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THE human skull is the subject of an endless series of minor variations; indeed, so numerous do we find these, that it is proverbial that no two crania are absolutely alike. These variations, however, are usually matters of minute detail, and seldom, to any extent, interfere with the typical oval shape of the head. In a few rare cases, however, we do meet with abnormally developed crania, characterised by marked peculiarities of configuration quite independent of race-variations. One of the most remarkable of these, is the form known as the scaphocephalic, or boat-shaped skull, so named by Von Baer, on account of the curious laterally-flattened tempora and keel-like vertex, prolonged into a sharp angle behind.

The history of the recognition of this deformity is interesting. The first notice of a case of the kind is in Sundifort's *Exercitationes* (Lugd. Batav., 1785, lib. ii, cap. i); but this example is imperfect, as being the subject of disease; also, in the *Museum Anatomicum* of the same author, occurs the second mention of this skull-form. The third instance is described by Blumenbach, in his first decade of skulls of various nations; the fourth and fifth by Virchow, in his paper, *Ueber den Cretinismus und über Pathologische Schädelformen*, 1851). Dr. Minchin, Professor of Botany in the Royal College of Surgeons of Ireland, in the *Dublin Quarterly Journal* for November 1856, described and figured a sixth instance in a living boy, and two skulls from the Museum of the Royal College of Surgeons in Ireland, and a calvarium from the same collection. Lucæ, in a paper on the Architecture of the Human Skull, published in Frankfort in 1857, mentions two examples of the same deformity; and the same author, in a more recent paper, *Zur Morphologie der Rasse Schädel*, published in 1861, states that he has seen two others of the same form, one being interesting as an hereditary malformation. Von Baer, in the *Memoires of the Imperial Academy of Science in St. Petersburg* (7th series, vol. ii, No. 6), has given description of two other examples; and a sixteenth is given by Welcker (*Untersuchungen über Wachstum und Bau des Schädels*. Leipzig: 1862). More recently, Gustav von Düben has devoted much time and attention to the elucidation of the nature of this form of cranium; and has published notes of four crania, and three living instances of scaphocephalus, in his paper, "*Kranier med tidig förbening af pilsömnen*,"* Stockholm: 1864. Professor Turner of Edinburgh, in the *Natural History Review* for January 1864, describes two skulls, a calvarium and a cast, illustrating this deformity; he also refers to three instances in living persons; and Dr.

* I take this opportunity of returning thanks to my friend A. R. Minchin for his kindness in allowing me the use of a translation of this paper from the Swedish; as but for his assistance, it would otherwise have been a sealed book to me.