ON THE CONDITION OF THE REFLEXES
IN CASES OF
INJURY TO THE SPINAL CORD;
WITH SPECIAL REFERENCE TO THE INDICATIONS
FOR OPERATIVE INTERFERENCE.

BY

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ON February 25th of the present year a paper was read before this Society by Dr. Charlton Bastian on the "Symptomatology of Total Transverse Lesions of the Spinal Cord, with special reference to the Condition of the various Reflexes." The author pointed out that, contrary to the generally accepted teaching, the deep reflexes were abolished in such cases; and he supported his contention by cases observed by himself, and by reference to the observations of others.

In the discussion which ensued I ventured to speak of my own experience of injuries of the spinal cord, and stated

that in twenty-two cases observed during the past six years at St. Bartholomew's Hospital the reflexes were never exaggerated when the spinal cord was completely crushed. Since speaking on this subject it has seemed to me that, considering the importance of the issues raised, it would be advisable to record somewhat more in detail the cases I have observed, and I am encouraged to do so by the fact that in but few published examples of injury to the spinal cord is there any definite statement of the conditions of the reflexes.

I am aware that the opinions expressed in this paper are at variance with the accepted doctrines of physiology and with the results of experiments, but the facts I record can be supported by the testimony of various independent observers who have seen the patients with me, and I have in all the cases demonstrated the conditions of the reflexes to the students dressing in the surgical wards of St. Bartholomew's Hospital. Microscopical preparations of the spinal cords were made in most cases, and for several of them I am indebted to my friend Dr. Howard Tooth.

For the purposes of this paper I have taken twenty-one cases of complete crushing of the spinal cord, in all but one of which this condition was confirmed by post-mortem examination. In ten cases, however, the patients survived but a few hours, and I have not therefore thought it advisable to make use of them in considering the state of the reflexes, although I have alluded to the conditions found at the autopsies in considering the question of operative interference. I may state, however, that in no single case were any reflexes or rigidity of muscles shown, although, on the other hand, in the more rapidly fatal cases they were not examined for by those who treated them, and such patients were not seen by myself.

In the eleven other cases, notes of which are appended, the various reflexes were especially observed by myself as well as by others, and records were made at the time.

I have also given brief notes of cases of injury of the spinal cord when from the symptoms it was evident that

there had not been complete solution of continuity, and have pointed out that in these the reflexes are increased. I may further add in explanation of the term "fracture dislocation" which is frequently employed, that by it is implied a partial dislocation of the body of one vertebra from that of another, combined with fracture of the body or processes of the displaced bones.

Cases of Complete Transverse Lesions of the Spinal Cord.

CASE 1.—T. B—, æt. 45, fell through a window on to his head on August 7th, 1888. On admission under Mr. Willett he complained of pain in his neck and of loss of power and of sensation in the trunk and limbs. He was found to be completely paralysed in the lower extremities and the trunk. There was anæsthesia of the abdomen, and of the thorax below the nipples. Respiration was almost entirely diaphragmatic. There was incontinence of fæces and retention of urine. The arms were not paralysed.

9th.—Priapism was marked.

10th.—Reflexes examined. The legs and thighs are flaccid; there is no clonus or rigidity; the knee-jerks are absent on each side; there is no reflex on tickling the feet.

The patient developed cystitis and bronchitis, and died on September 23rd, the reflexes not having returned.

Post-mortem examination showed a fracture dislocation at the second and third dorsal vertebræ. There was no pressure on the cord, and the membranes were uninjured. The spinal cord itself appeared natural until it was cut open; its structure then appeared blurred and homogeneous, and a microscopic examination showed below the seat of fracture the usual typical descending degenerations.

CASE 2.—John H—, æt. 58, fell from a height on to his head on July 17th, 1887, and was at once paralysed. He was admitted into Colston Ward under Mr. Langton,

and on July 23rd there was found to be complete anæsthesia of the lower extremities, of the abdomen, and of the thorax below the second intercostal space. The respiration was diaphragmatic. The sphincter of the rectum was paralysed. The urine was retained. The extensors of the forearms were paralysed, but the elbow, fingers, and wrists could be flexed. There was no rigidity, no ankle-clonus, and no knee-jerks. There was slight sole reflex on each side, but no cremasteric reflex.

Three days later the patient died.

A post-mortem examination showed a fracture dislocation of the fifth and sixth cervical vertebræ, the fragments being in good position and not compressing the cord. The membranes were untorn, but the cord was completely crushed to a pulp.

CASE 3.—A man, æt. 42, fell on the back of his head on October 17th, 1887, and at once lost power in his lower extremities. He was admitted into Colston Ward under Mr. Langton. The day after the injury his lower extremities were found to be completely paralysed, the abdominal and thoracic muscles were paralysed, and sensation was lost below the third rib in front. There was incontinence of fæces and retention of urine. There was but little anæsthesia of the arms, but the extensors of the forearms, wrists, and fingers were paralysed. There was slight priapism.

On October 21st the reflexes were examined. Both deep and superficial reflexes were completely lost in the lower extremities. There was no rigidity.

November 7th.—On tickling the soles there was decided movement of the toes. No clonus or rigidity.

The patient died a week later, and a post-mortem examination showed a fracture dislocation of the sixth and seventh cervical vertebræ, without any displacement. The spinal cord was quite pulped.

CASE 4.—A lad, æt. 18, fell down a lift on June 17th, 1887, and was admitted into Rahere Ward, under the care

of Mr. Baker. The same day he was found to have complete paraplegia with retention of urine and incontinence of fæces. Respiration was diaphragmatic, and sensation was lost below the nipple. The extensors of the forearms and wrists were paralysed.

On June 20th there was found to be some further loss of sensation, so that now anæsthesia was complete below the second rib. Priapism was marked, and was increased by catheterisation.

29th.—Examined for reflexes. There was no rigidity of the lower extremities, and both superficial and deep reflexes were absent.

November 1st.—Still no reflex in lower extremities.

December 1st (twenty-four weeks after the accident).—Distinct return of the sole reflexes, the toes being moved when the foot is tickled. No patellar reflex; no clonus; no pectoral reflex. The patient says that he has a tingling and pricking sensation over the chest when a catheter is passed, and after its passage there is profuse perspiration over the head, face, and neck, and the development of a bright red rash which persists for fifteen or twenty minutes.

31st.—No change in the reflexes.

January 26th, 1888.—The patient died.

A post-mortem examination showed a fracture dislocation at the junction of the seventh cervical and first dorsal vertebræ. There was no displacement at the time of death. The membranes were intact, but the spinal cord was crushed to a pulp.

CASE 5.—H. W—, æt. 54, fell from a height of sixteen feet on to a wall, striking his back. He at once felt as though he had lost his legs.

He was admitted under the care of Mr. Morratt Baker into Harley Ward, where two days later, *i. e.* on September 11th, 1884, his breathing was found to be chiefly diaphragmatic, and his abdominal muscles and lower extremities to be completely paralysed. His urine was retained, and

motions were passed involuntarily. His legs and thighs were quite limp and flaccid, and there were no knee-jerks or ankle-clonus on either side. The cremasteric, sole, and epigastric reflexes were also absent.

The patient gradually sank, and died on January 30th, 1885, from suppurative nephritis, having survived the accident nearly six months.

A post-mortem examination showed that the bodies of the fifth and sixth dorsal vertebræ had been fractured. The fracture had united, but there was no compression of the cord. The dura mater was a little thickened, but was not torn open.

The spinal cord looked as though it had been pinched opposite to the seat of fracture, and was here quite diffuent. Microscopical examination showed that it was completely disorganised.¹

CASE 6.—Mary C—, æt. 54, fell downstairs on November 17th, 1886, and was found lying on her back in a helpless condition.

She was brought to St. Bartholomew's Hospital, and was admitted into President Ward under the care of Mr. Willett. She had severe pain in the neck; the legs, thighs, abdomen, and thorax were anæsthetic; the respiration was diaphragmatic; there was complete loss of power in all the muscles of the lower extremities; the sphincter ani was paralysed, and the urine was retained. The upper extremities were partially paralysed, the pectorals, deltoids, and biceps alone acting. The hands and forearms were nearly quite anæsthetic. The lower extremities were flaccid, and the knee-jerks and the sole reflexes were absent. The patient died on November 20th, three days after the injury, without there having been any alteration in the symptoms. A post-mortem examination showed a fracture of the fifth and sixth cervical vertebræ with complete crushing of the cord. The cord was not compressed by displacement of the fractured vertebræ.

¹ See report by Dr. Tooth in 'St. Bartholomew's Hospital Reports,' vol. xxi, p. 141.

CASE 7.—Florence S—, æt. 31, fell on her head on July 11th, 1885, and was at once paralysed. She was admitted into Lawrence Ward under the care of Mr. Smith. There was complete paraplegia with incontinence of fæces and diaphragmatic breathing. Sensation was lost on the inner side of the arms, and the extensors of the forearms and wrists were paralysed. There was no rigidity, and the reflexes of the lower extremities were lost. The patient died in four days, and a post-mortem examination showed a fracture dislocation of the fourth and fifth cervical vertebræ with complete crushing of the spinal cord. There was no pressure on the cord by displaced fragments, and the dura mater was not torn.

CASE 8.—Henry S—, æt. 41, fell from a height of twelve feet on to his head, and was admitted into hospital under Mr. Baker in an unconscious condition on March 14th, 1889. He soon regained consciousness, and then complained of great pain in the neck, and was found to be completely paraplegic. A more complete examination next day showed that there was complete anæsthesia below the level of the second rib, and paralysis of the muscles of the chest, abdomen, and lower extremities. Urine was retained and fæces were passed involuntarily. In the upper extremities there was numbness in the distribution of the ulnar and internal cutaneous nerves. The lower extremities were quite flaccid, and the sole reflex and the knee-jerk were absent on each side. There was no clonus. The patient survived a week, but the reflexes did not return. A post-mortem examination showed a fracture dislocation of the sixth and seventh cervical vertebræ without any material displacement of fragments. The dura mater was intact, but the spinal cord was completely crushed.

CASE 9.—A man, æt. 63, fell from a scaffolding on to some rails on December 6th, 1884, and was at once paralysed. On admission into St. Bartholomew's Hospital under Mr. Baker he was found to have complete loss of

sensation and of motion below the second rib, with paresis of the left arm. The epigastric and sole reflexes were absent, as were also the knee-jerks. The limbs were flaccid. The patient died the day after the accident, and a post-mortem examination showed a fracture dislocation of the fifth and sixth cervical vertebræ with laceration of the spinal cord.

CASE 10.—A man, æt. 43, fell off a ladder on April 12th, 1888. On admission into Henry Ward under Mr. Smith he was found to have complete loss of sensation and motion in the lower extremities, with loss of sensation below the level of the fifth rib, and paralysis of the muscles of the abdominal wall as well as of the lower intercostals. He complained of great pain in the back. The urine was retained, but there was marked priapism; there was also incontinence of fæces. Further examination showed that the lower extremities were quite flaccid, and that the sole, epigastric, and patellar tendon-reflexes were all absent. There was no clonus. As there was no change in the condition of the patient he was sent to an infirmary ten days later.

CASE 11.—W. G—, a man æt. 52, was admitted into Colston Ward under the care of Mr. Langton on March 12th, 1890. He had fallen from a scaffold, and was picked up unconscious. The day after admission, when he had recovered consciousness, I found him quite paraplegic, with absolute anæsthesia and loss of power below the third rib. There was marked priapism. The hands and arms were feeble, but there was no definite paralysis or loss of sensation. Breathing was difficult. An examination of the reflexes showed complete loss of patellar tendon-reflex with absence of clonus and rigidity. The cremasteric reflexes were absent, but touching the skin of the penis caused increased priapism. There were no sole reflexes.

The following day I examined him again with Dr. Ormerod. The right sole reflex had returned, but the

deep reflexes were unaltered. The contraction of all the muscles of the lower extremities to a direct blow was much increased. The supinator reflex on the right forearm was increased.

On March 15th the left sole reflex had returned, and the area of anæsthesia had extended as high as the second rib.

On March 17th the patient died of congestive pneumonia without further alteration in the reflexes.

A post mortem examination showed a fracture dislocation of the first and second dorsal vertebræ. The dura mater was untorn, but the spinal cord was completely crushed, and was quite diffuent.

Cases of Partial Lesion of the Spinal Cord.

CASE 1.—J. R—, æt. 16, was admitted into Harley Ward under Mr. Marrant Baker on June 6th, 1889, having fallen from a height of six feet on to the back of his head.

On admission he was found to be conscious, but could not nod his head or rotate it on account of pain in his neck. No deformity could be seen. The patient complained of “numbness all over,” but was not completely paralysed, although unable to stand. Both legs could be moved, but the left leg was very feeble, and neither limb could be raised from off the bed. Both knee-jerks were increased. The next day he was more carefully examined, and it was found that he could move the right leg feebly, although the left was quite paralysed. The intercostal muscles acted feebly. Urine was retained, but the sphincter ani was not relaxed. The hands and forearms were not paralysed, but were very weak.

June 8th.—Can move both legs a little, and has passed his water naturally.

11th.—Has gradually gone back again, and has retention of urine and further loss of power in the left leg.

The left knee-jerk is absent, but the right knee-jerk is increased.

13th.—Better again. Both knee-jerks are increased. He has more power in the legs and in the arms. Passes urine normally.

20th.—Some rigidity of both lower extremities with exaggerated knee-jerks and clonus. The left arm and leg are very weak, and can scarcely be moved. The right arm is fairly strong, but the right leg is very feeble. Micturates naturally.

July 25th.—Has slowly improved in every way, but has a good deal of pain in the neck.

August 29th.—Continues to improve. Sensation has returned considerably in both upper and lower extremities, and there is definite increase of power in the left arm and leg.

October 3rd.—Going on well. Patellar reflexes still exaggerated, and some tremor in quadriceps extensors. Ankle-clonus well marked. Sole reflex increased. Lower extremities still a little rigid. Power of movement much improved.

24th.—Knee-jerks not so much exaggerated. Is much better in every way, and gets out of bed in the evening.

November 21st.—Can walk with the aid of a stick.

29th.—Discharged. Left leg and arm weak. Reflexes of lower extremities still exaggerated.

February 20th, 1890.—Almost quite well, but complains of some remaining weakness with left arm, although this is rapidly improving. Knee-jerks are still exaggerated, although but slightly.

CASE 2.—T. L—, æt. 39, fell off a van on April 19th, 1884, and injured his back. He was admitted into Colston Ward under Mr. Langton. His legs felt numb and powerless directly after the injury, and on examination at St. Bartholomew's he was found to be almost quite paralytic.

Next day his reflexes were examined. The lower ex-

tr extremities were rigid, the patellar reflexes were increased, and tickling the soles caused spasmodic twitching of the muscles of the thigh and leg.

The patient quickly improved, and in three days' time he was again able to move the legs and thighs. A week later he could get out of bed and walk with the aid of crutches.

Numbness, rigidity, and increased reflexes continued for some months.

CASE 3.—A man, *æt.* 28, fell and struck his spine, and at once felt a loss of power and numbness in his lower extremities. He was admitted into Abernethy Ward under the care of Mr. Savory, and was found to have partial paralysis of the legs and thighs, but no incontinence of *fæces* or retention of urine. He could lift the legs off the bed whilst lying down.

Next day further examination showed increase of knee-jerks on both sides, muscular tremor and spasm on tickling the soles, and ankle-clonus. He rapidly improved, and made a complete recovery in fourteen days.

I have purposely abstained from entering into any lengthy details as to the course and complications of the cases here recorded, as the object of this paper is to direct attention to a few definite observations. The first and chief fact which is demonstrated is that in cases where the spinal cord is completely crushed in the cervical or dorsal regions the deep reflexes are at once lost and do not return. I am aware that it has been formerly suggested as an explanation of this that the cause of their disappearance is shock, but this theory has never been supported by anything in the shape of proof. On the other hand, it is clearly shown by the cases here described that after the lapse of a time much more than sufficient to allow of recovery from shock the deep reflexes are absent. Thus one patient survived a month, another six weeks, a third five months, and a fourth ten months.

The superficial reflexes are also generally lost immediately after the accident, although this is not invariably the case, and they, unlike the deep reflexes, may in time return. In Case 2 the superficial reflexes were never lost. In Case 3 they returned on the eighteenth day, but in Case 4 not until the twenty-second week. In Case 5, when the patient survived five months, they were not noticed to return, and this also happened in all the other patients who survived for periods varying from one day to six weeks, with the exception of Case 11, in which the sole reflexes returned on the second and third days following the injury.

On the other hand, when the cord has been injured, and when it is compressed, but when also its continuity has not been entirely interrupted, the reflexes are not only preserved, but may be, and generally are exaggerated.

The bearing of these facts on the question of operation is obvious. If the limbs are flaccid and reflexes are absent the diagnosis is that the cord is completely severed; and, as it is known that in the human subject such a lesion is never repaired, operative interference is useless, and should not be undertaken. If, however, in spite of paralysis more or less complete there is rigidity and increase of reflexes, then the diagnosis is that there is but partial severance of the cord, and if there be any indications for operation, such as apparent compression by displaced bone, there is justification for such a measure.

It must, however, be pointed out that operative interference can but seldom be of avail, and that in the vast majority of cases of fracture dislocation of the spinal column no good whatever can arise from it. This is made abundantly clear by a consideration of the conditions found on post-mortem examination. Among the ten fatal cases I have recorded where the spinal cord was found, post mortem, to have been completely crushed, there was no pressure by displaced bone in any one. In addition to these I have made post-mortem examinations of nine other examples of fracture dislocation, and of one

of simple dislocation without fracture, and in not one of them was there found any compression of the cord by displaced bone. From a consideration of the conditions found on post-mortem examination of these twenty cases I think it may be concluded that the cord is injured by a forward dislocation of the body of the upper of the two vertebræ involved in the injury, and that the spinal cord is suddenly and violently stretched and crushed across the upper and posterior margin of the body of the vertebra below. As soon as the force which has caused the injury is withdrawn the displaced vertebra is restored partially or entirely to its natural position by the elasticity of the ligaments and the contraction of the muscles. Unfortunately, however, the mischief is already done, and the cord is injured beyond repair. In most of the cases I examined I found the dura mater uninjured, and in many of them the cord within it at first appeared natural. It was often only on section that the amount of injury inflicted could be estimated.

In conclusion I would point out that although I consider there is sufficient proof that in all cases of total transverse lesion of the spinal cord the deep reflexes are abolished, and that in cases of partial lesion the reflexes are increased, I am not prepared to assert definitely that in all cases of partial lesion there is necessarily such increase. It may be that in some severe cases of this class the reflexes are also abolished for a time, and I am acquainted with a case, which I did not myself observe, in which in a patient with undoubted partial lesion the reflexes were said to be abolished.

This is a matter which may easily be determined by future careful examination.

(For report of the discussion on this paper, see 'Proceedings of the Royal Medical and Chirurgical Society,' Third Series, vol. ii, p. 114.)