Clinical Report
of a case of
Hemiparaplegia Spinalis,
with Remarks;

Being a Thesis by

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Introductory Remarks.

I have recorded in the following pages a case of unilateral lesion of the spinal cord, on a level with the lumbar medulla. Comparatively few such cases have been chronicled, and consequently the symptoms occurring in them have not been fully recognized. The greater number of recorded cases will be found referred to, by P. Brown-Séquard, in his lectures on Spinal Hemiplegia and Hemiparesis, published in the Journal for 1868 and 1869. Ponscari in his "Physiologie des systèmes nerveux" presents in a tabular form those cases with which he is familiar. To the former observer is due the credit of having first recognized the symptoms consequent on a lesion in one half of the cord, and to him also must the explanation of many of those symptoms be attributed. But there still remains great obscurity regarding the functions of the cord, in the relation of its segments at different levels, in the mutual relations of the lateral halves, in its relations with higher centres, with peripheral nerve termination, and with the sympathetic system. It can only be by careful clinical examination that these mysteries will become unravelled, and disputed points finally settled. I have endeavoured, from the study of this case, and comparing it with others, to elucidate a few doubtful points. I have more particularly dealt with the question of muscular sense, and I think that a few preliminary remarks upon that point is necessary.

While thinking over the condition of my patient herein recorded, I became dissatisfied with the current explanation, that muscular sense is conveyed by motor paths because it occurs on the side of the paralysis. On the contrary I came to the conclusion that sensory nerves and paths conveyed the muscular sense, but that motor paths had also to do with it, but not by centrifugal conduction. In fact the description, as given in the text, was clearly in my mind...
But I had not sufficient confidence in my own speculations to incorporate them in this thesis; especially as I was situated in a country town with very limited means of reference, and could find but slight confirmation of my views in medical and physiological works. I had the opportunity of laying my views before Dr. Nose of Manchester who informed me of Professor Bain’s writings upon this subject. Procuring his works on the “Senses and Intelect” to my delight I there found expressed in elegant language the all but inarticulate thoughts that I had attempted to express in my crude phrasology.

The part played by motor nerves in the constitution of muscular sense is the expressed by Bain; there is a “sensibility accompanying muscular movement, coinciding with the outgoing stream of nervous energy, and does not as in the case of pure sensation, result from any influence passing towards by way of sensory nerves.”

Extract the following portion of my from my original notes on the subject, wherein is shadowed forth the same idea expressed by Bain: “In the consideration of the part that the motor paths play in the recognition of this sense, we must take into account the exercise of the will. When the patient will a certain movement to be performed he is conscious of the amount of nervous discharge that has been liberated to set the muscle in motion. As the muscular energy will be in a known ratio to nervous energy he will be conscious of the result.”

With the exception of Ferrini I find no medical authority quoting Bain’s explanation, and Ferrini only quotes it in the attempt to upset it. I have not come across any attempt made to apply it in the explanation of the manifestations of disease as I have tried to do.

Searching for the reasons of the presence of this sense while there was reported an absence of other sensations I discovered the retention of the sense of touch as distinct from the recognition of
separate points. As I point out in the text, the method hitherto
employed of recognising anaesthesia by testing with separate point
is fallacious. For, by separate point, we are enabled to judge of
the patient's power of simultaneously perceiving impressions on adjacent
parts of the skin only, but not information as to the delicacy
of his perception of the impression made on the peripheral extremity
of the nerves of touch by very fine contact.

The vomiting and rectal functions present in this case in-
teresting feature, that I have not elsewhere seen referred to, and
are therefore treated by me at some length.

Books to which Reference is made.

Jenner's Cyclopedia of the practice of medicine Vol. XL, XII.

Rus' Diseases of the Nervous System

Powers' " " Special Cord 2 ed.

Bramwell's " " " " " "

Brown-Sequard's Lectures in Lancet for 1868 & 1869

in Diagnosis & Treatment of the functional nerves

Ferreir's Functions of the Brain.


Lanceaux's Latin in Syphilis

Foster's Text Book of Physiology

Pomaré's Physiologie du systeme Nerveux.

Davies' Senses and Intellect.

Bolton Case in Centralblatt fur Nervenkrankhede (Aug. 1880)

Scoul Case

" " " Lancet 1865 Vol I (Radeloff's Case)

" " " " Vol II (Bazin's Case)
Nicholas Pollard, aged 38 years, a Mercer by trade, but working the last 6 years as a Baker, residing at 5 Radcliffe House, Burnley. Examined on 13th December, 1880.

Patient complains of, loss of power in left leg, want of feeling in right leg, and difficulty in emptying his bladder and bowel.

History of the present attack. About the end of the preceding June, an indefinite feeling of "numbness or deadness," began to crop over the right leg. About the middle of the following month (July), the patient found that he was unable to have connection with his wife. A fortnight later he became conscious that he was gradually losing the power of emptying his bladder, and this difficulty increased until he could pass but a few drops of urine at a time. This last condition continued for about a week, when he sent for a doctor, who passed a Catheter, and drew off a large quantity of urine. He himself employed the Catheter after this for about 3 weeks, when these gradually returned the power to evacuate a small quantity, upon which the patient desisted from using the Catheter. A difficulty in getting the bowels moved manifested itself at the same as this urinary difficulty. Castor Oil and injections were unavailingly tried. Obtaining no relief he one day passed his finger into the bowel, and slowly withdrawing it the feces followed, and he had a comfortable motion. He says there is a constant bearing down sensation in the region of his seat, as if he wanted to have his bowels moved, but without the above device he cannot succeed.

A month ago (about the middle of November 1880), the left foot also
began to feel numb, and the power gradually left the limb below the knee, so that during the last 10 days he has had to trail the left leg behind him when he walked.

His previous health has been very good. He was injured 9 years ago by a brick falling down the shaft of a mine in which he worked. It hit him on the right hip, causing a large wound from which he made a perfect recovery. He had a general chills 12 years ago. Can account for no accident or injury to the spine.

Social Condition. He is married and has had 2 children. The elder died from "Consumption of the Blood." The younger child is 13 years of age and healthy. His wife is alive and well. He has always been in comfortable circumstances, and on the whole fairly temperate. He has had to undergo the exposures associated with the 2 trades he has followed.

Present Condition. The patient is 5 feet 10 inches in height. Of fair complexion, well built and muscular. A fairly intelligent, shrewd man.

His SKIN is moist and warm in the trunk and arms. The legs feel rather cold. Temperature in axilla is 93.5. The index of the Thermometer at 96° is not raised when placed between the legs.

There is a depressed cicatrix about the size of a shilling immediately behind the Right Trochanter – the result of the aforementioned injury. There are 2 small cicatrices in the left groin resulting from abscesses which, he says, followed upon a blow on the Testicle, from a splinter of coal.
In apparent sincerity he denies the possibility of a chancre. I cannot detect any cicatrice on the penis. Of possible sequelæ, there is only his statement that his hair fell off in considerable quantities, some years ago, and that it has subsequently grown as thick as previously.

On the outer and upper part of his right leg there is a large red and inflamed patch, 6 by 3 in., with a blister about the size of a florin in the centre. The patient was unaware of this condition until I called his attention to it. After conjecturing for a time as to what might be the cause, he remembered that while sitting on a low stool, in the morning, he discovered that his bare knee was almost touching the bars of the grate on which a good fire was burning. From enquiry as to the position and posture I had no doubt but that this was the cause. I may remark that in a few days the inflammation disappeared and the blistered place became scabbed over. On the seat being removed a deep irregular sore was revealed which slowly healed up. The progress in healing, of this burn was such as one would expect in any healthy person.

Nervous System.

Motor Phenomena. The patient usually lies in bed, and when there, is raised almost to a sitting posture, with his legs laid straight before him. As he thus reclines his left foot points with the proximal phalanges of each toe slightly
drawn back, and the distal phalanges slightly flexed. The voluntary movements of the toes are weak and their extent limited. Such is also the condition of the movements at the ankle, knee, and hip joints. They however approximate natural strength the higher up the joint is situated.

The Right foot is not pointed like the left but lies in a natural position. Neither are the toes bent like the left. The movements of the Right foot and leg are good and strong.

The patient gets out of bed with difficulty, having to assist the Left leg in its progress with his hands. When standing up he has to balance himself for a little with the aid of convenient objects. He can walk, but does so trailing the Left leg, in the manner of an ordinary Hemi-plegic! Standing with his heels together he sways from side to side and before backwards, ultimately falling towards the left side. During the time he is standing there is observed an ever changing contraction and relaxation of the tendons of the Right foot and leg. These movements are similar to those in the leg of a man who attempts to stand on that leg alone. There is no action whatever to be seen or felt in the tendons of the Left leg. When he recovers from the inevitable stumble there follows a series of clonic contractions of the Left quadriceps muscle.
No motor abnormalities are detectable in any other part of the body.

**Sensory Phenomena.**

Patient complains of a numbness in the Right leg and Right side of belly as high as the 12th Rib. He says that some weeks ago he felt pain in his left side about the level of the 11th and 12th ribs, but that it is now gone. The sensations on the Left side as far as one can judge, are natural. Examination carefully made for hyperaesthesia reveals no such condition on either side of the body.

The sensibility to Touch lightly applied is very fair on the Right leg, and he localises the spot touched with considerable accuracy. He is unable to distinguish 2 points applied at once, thinks there is but one, and indicates its site some place between the points. Even when the points are a foot distant it is only after pressing hard, and waiting some time that he becomes aware that there are 2 places being acted upon.

The sensibility to Pain and Heat is almost entirely abolished. Striking testimony is afforded in proof of this, by the fact of the patient's unconsciousness of the burning of his leg, previously described. Still he is vaguely conscious of these sensations, when his mind is actively engaged searching for them. These abnormalities extend all over the Right leg, the right side of the abdomen up
to arise drawn from a point in the middle line, a little above the symphysis pubis, slanting up-
wards and outwards to the level of the 12th Dorsal Vertebra. In the upper part of the thigh and in the abdomen these abnormalities are not so well marked as the region below. They are also limited to the Right side of the scrotum and penis — the mucous membrane as well as the skin exhibiting the diminished sensations, although, not to so marked a degree.

The patient with his eyes closed knows readily where his legs are placed, and also distinguishes well between weights of a few pounds.

**Reflex Phenomena.**

On tickling the sole of the Left foot, the movements consequent are exaggerated. On tickling the Right sole the movements are natural.

Tendinous Reflexions are very much exaggerated on the Left side. The patellar tendon reflex can readily be set up by striking the tendon below the patella and above it, and into the muscle as high as 8th above the patella. The excitability diminishes the farther away from the patella that the muscle is struck. The reflex contraction is readily set up by hitting the patella on the sides so as to cause it to move, but it is not set up if the patella be hit fair in the centre, so that it is not moved. Percussion of the bones in the neigh-
Bovist's condition does not cause the contraction, unless the tissues in connection with the tendon or the patella are also stretched by the blow. Slight reflexions are got in the tendons of the tibialis anticus and extensor of the great toe. On tapping the tendons of the common extensor of the toes, in addition to contraction in this muscle itself, there are occasionally excited contractions in the long extensor of the great toe, and in the quadriceps. There are also communicated reflexions in the long extensor of the great toe, from tapping the tendons of the peronei and the tibialis posticus. Ankle blonics is readily set up by forcible dor-si-flexion of the foot.

Examination of Spine and Cranium reveals no abnormality.

His mental condition is perfectly clear. Special Sensors are quite normal.

Genito-Urinary System.

The Sexual functions are still in abeyance.

He micturates frequently and with some difficulty. Since he has been able to pass water, and left off using the catheter, he has had to perform the act bending forward and straining hard. After he had evacuated the bladder in this manner to his own satisfaction, I detected by percussion that it was not empty, and on passing a catheter I
drew off several ounces of urine. He has no pain at any time in the region of the bladder. The urine betrays no chemical or microscopic abnormality.

**Digestive System.**

Tongue clean; swallows well. He has a good appetite and no discomfort after food. The bowels cannot be moved save by the aforementioned device (passing his finger into the rectum, the force following the withdrawal of the finger). He has taken purges in large quantities. On rectal examination with the finger I find that the sphincter yields more readily than natural. I could detect no other abnormality.

All the other systems are quite healthy.

**Progress.** The morning after the examination the patient complained of jumpings in his legs especially the right. For a few days after this he appeared to improve in so far that he walked better, and was a little more conscious of nipping in his right leg, and the tendon reflex was not so marked in the left.

A few weeks after he began to get worse and I made another detailed examination of him when his condition was as follows —
Examined 16th January 1881.

He complains of a pain that has come into the left side of his belly. The pain is much aggravated from contact with the bed clothes. There is now total inability to evacuate the bladder or the bowel. For the former condition he has always to use the catheter, for the latter copious injections of soap and water, and castor oil have been employed, but although the injections come back, no feces accompany them.

**Motor Phenomena.** He is now unable to walk and when he gets out of bed for any purpose, he does not know where his legs are, and is in constant danger of falling, on account of the sudden uncontrollable jerkings of his Left leg. There is great loss of power in the Left leg, but it is doubtful if there be any loss in the Right leg.

**Sensory Phenomena.** In the Left leg, sensibility to touch is fairly good. Sometimes he can distinguish points 3 or more inches apart but far oftener he thinks there is only one. Keeping the points applied and exerting more pressure on them after a time he is able to distinguish the 2 points. He cannot always tell when he is being touched on the Right leg. When he does know that...
that he has been touched it is some little
time after its application before the impression
is recognised. Two separate points he is in-
capable of distinguishing, and when the point
are pressed hard the leg gives an incontrollable
jerk, and then the patient has an indefinite
feeling of pain.

He is unable to distinguish warmth from cold
on the Right leg but does so easily on the Left.
When touched the transmission of the sense of
pain is delayed in the Right leg from one to
two seconds after which time the leg gives an
involuntary start, and at the same time he is
conscious of the pain. By a great exercise of
the will he can partially prevent this start.

He is now unable to tell in what position
the legs are placed. In neither leg can
he distinguish between weight.

There is hyperaesthesia of the Left side of the
abdomen corresponding to the place where the
patient complained of pain when the bed clothes
touched him. The hyperaesthetic condition of any
given spot is not constant. Touching lightly
with the finger one place he starts with the
pain. After a few minutes I return to the same
place I find that it is not painful. Upon
carefully examining these points I find that the
hypermasthesia follows a fairly defined course, com-
mening 2-3 inches to the Left of the middle
line a little below the level of the umbilicus and passing round the side on a level with the 17th and 12th ribs to the 12th dorsal vertebra. Its breadth can be embraced in 2-3 inches. Similarly on the right side a narrower band, a little lower down, extends from the middle line round to the 1st lumbar vertebra. This band besides being much narrower is not so sensitive as that on the left side. Above the hypogastric part I have not been able to satisfy myself that there is any anaesthesia.

Reflex Phenomena. The reflex contraction in response to tickling the sole of the right foot is very much increased. But on the left it is diminished.

The tendon reflex is very much exaggerated on the right side, and is now very similar to the reflexions on the left side, as described before (page 6) both in the patellar, and in the tendon of the foot, and also in the communicated reflexions. The ankle clonus however is but slightly marked.

The condition of the tendon reflex on the left side is similar to what it was in the first examination.

Percussion along the spine elicits symptoms of considerable tenderness over the 11th and 12th dorsal vertebra, and 1st lumbar vertebra.
January 19th. Knowledge of weight a little confused on the Right leg but very much so on the Left. He can distinguish between a few ounces and 5 or 6 lb. on the left side but between 1 lb. and 2 lb. he cannot tell the difference. Bowels have not been moved for the last 10 days. Ordered salam. 3/4 Calomel gr. IV. take it. One at night. Distending enemas. castor oil have proved unavailing.

January 21st. The bowels were freely moved yesterday. At first large hard stools, afterwards several loose ones came away. He had no difficulty in defecating but when stools became loose he was unable to retain them and they passed out before he could be ready.

Sensory Phenomena. On very careful examination with the aid of a pin I find above the hyperaesthetic area on both sides of the abdomen an anaesthetic part. On endeavouring to define this anaesthetic area, trusting for evidence to the patient's involuntary movement and subjective impressions, I am unable to mark it out accurately because of the variability of the impressions produced. Thus having marked in ink, spaces in which the patient feels the prick much less acutely than natural, I proceed to other places. On returning to the first spaces, I find
them, judging from his starting and exclama-
tions of pain, hyperesthetic, though I prick him
as slightly as previously. This variability is
distributed more or less over the whole front of
the belly except in one place 2" by 1" in size,
on the right side which remains anaesthetic.
Instead of some places becoming anaesthetic
after being hyperesthetic he states the feeling
to be about natural. The dulled impressions
are all either in the upper part of the hyper-
esthetic area, or slightly above it, where they
occasionally intermit with the natural.
But even the hyperesthetic part extends over a
variable area. Thus I have found it as low as
the anterior spine spine on the left side, but
on again testing this part I find it natural.
I have been unable to mark out these areas on
the patient on account of the extreme variability
of the impressions produced.

On suddenly extending the passively flexed
left leg (he is unable voluntarily to flex it), there are
for a few seconds vibratory spasms of the leg, chief
or entirely due to the clonic contractions of
the quadriceps extensor cruris.

January 29 th. There is no response to
tickling the left sole. There is excessive con-
traction of the muscle from tickling the right
Electrical stimulation.

Sensation to the interrupted current on the right leg is diminished as compared with the left leg and other parts of the body. The contraction of the muscles of the left leg to the interrupted current is very easily set up so much so that the reaction is obtained with a current so weak that the patient is aware of no other sensation save that of touch, showing also insensitivity to electro-muscular contraction on this left leg. On the right side all the muscles are also readily made to contract but necessitate a slightly stronger current, and produce the sensation of muscular contraction.

Thickness of thigh 8 in. above patella on right 18 in.

Left 17 1/2 in.

Thickest part of right calf 11 3/4 in.

Left 11 1/2 in.

February 3rd. There is no reflex movement following upon tickling the left sole except when the roots of the toes are tickled, there being then a slight movement in the toes and the leg.

Neither hyperesthesia nor anaesthesia can now be detected save that an unvarying spot of anaesthesia on the right side, already men-
tuned, which still remains anaesthetic.

There is a slight painful enlargement of the left testicle. Drops of pus can be squeezed from the urethra. The pus is in all probability due to using the catheter which had not been properly cleaned. In a few days the testicle became much enlarged and excessively painful. The swelling gradually subsided, and a small abscess in the testicle was pointing when the patient left Burnley for Manchester Hospital on the 25th current. (February.)

February 23rd.

Motor Phenomena. There is great loss of power in the left leg, but it does not now fly from him as it used to do, while standing.

Sensory Phenomena. He has only a feeling of cold and numbness in the right leg. There is no pain anywhere. The anaesthetic spots on the right side of abdomen has now disappeared.

Sensitivity to light touch is good on both legs and he localises accurately the spot touched. He can detect 2 separate points to within three or 4 inches of one another on either leg, though on the right he takes a little time to make them out and is occasionally at fault.
Sensibility to pain is slightly diminished on the Right side. He can readily distinguish the means of inflicting the pain as pinching from pricking.

He cannot tell that a test tube filled with cold water is cold when applied to the skin of the Right leg. One filled with warm he does not recognize unless it be kept for about a minute in contact with the skin of the Right leg, after which time he has a faint perception of the warmth. Very cold objects (as a solid piece of cold iron) applied to the lower part of the Right side of the abdomen and to the Right thigh, he shrinks from, declaring them to be very hot. After repeated testings he is at last able to discern that they are cold. The sensibility to differences in temperature is much less acute in the leg and foot than in the thigh.

He can tell accurately where the Right leg is placed, and roughly where the Left is placed. He can distinguish between different weights with the Right leg fairly well. Only between very heavy and light weights with the Left.

**Electrical Stimulation**. The Continuous current. The sensibility to this current is also diminished on the skin of the Right leg.

Contraction of all the muscles are equal on either side. The patient is not aware when those of
the left leg are thus made to contract.

**Reflex Phenomena.** Reflex movements are well marked in reply to tickling either sole.

Patellar Tendon Reflex is slightly exaggerated on the right leg; but is markedly so on the left. After the patellar reflexes have been tested a few times, they can be got by hitting the hamstring tendons and those at the ankle on the left side only. Reflexes can also be set up in the muscles to the toes. There is very little ankle clonus now producible.

Thickness of thigh 8" above patella on the right 17" left 17".

Thickness part of right calf 11½".

Do do left 11½".

There is still tenderness on percussion over the 11th and 12th dorsal vertebra.

The patient left Burnley for Manchester hospital on February 25th, 1881. He remained there for three months. His condition while there continued to improve; and for the last 6 months he has been the condition described in the following report of his examination.
Examination on February 25th 1882.
The general condition of the patient is very
good, and he has a healthy appearance. Latterly
he has been increasing in weight.

Nervous System

Motor Phenomena. The patient is
not now confined to bed. All day long he
is moving about and can walk distances of
4 miles with comparative ease.

He walks with an awkward "stumbling" gait,
scratching the ground with the ball of the
left great toe as the leg is trailed forward.

The "stumbling" character in his
gait appears to be due to two things, first
the flopping down of the somewhat helpless
left foot, and second to the stamping
quickly down of the right foot to save himself
from stumbling owing to the inability
of the left leg to sustain him.

Standing with his heels together, the eyes being
closed, he sways about but does not fall. The
tendons of the right foot and leg are seen
at this time to be actively playing while
those of the left are passive. His co-ordinating
power over his right leg is good and com-
plete as shown in his ability to trace circles
and figures on the ground with his big toe--
a feat impossible for him to accomplish with
All the voluntary movements of the hip are performed only to a limited extent, and slight resistance is required to prevent performance of any one movement.
his left leg. Although the feeling in the right leg is "deadened," he says he can walk with it and manipulate it as well as ever he could, while the left leg feels like a heavy weight requiring to be dragged along. Passive movements of the joints of the right leg are freely and easily performed. On the left leg, the ankle movements are stiff and limited in extent, those of the knee exhibit marked resistance, while at the hip joint the movements are free and unrestrained. The voluntary movements at all the joints of the right leg are natural in freedom and strength. But the voluntary movements of the toe, ankle and knee joints on the left side are feeble, while the hip movements are powerful. As he sits with the left leg fully extended in front of him he can flex the leg to a right angle with the thigh, but he cannot bring the leg farther back owing to the inaction of the hamstring muscles.

**Sensory Phenomena.** The right leg always feels cold, and when the other parts of his body are really cold, he feels as if cold water were running down his right leg. The sensation becomes more natural at the upper part of the thigh. The temperature of both legs does not vary.
the index of a Clinical thermometer above 96°. The
thermometer was applied for 10 minutes to each
calf surrounded with wadding.

The sensibility to light Touch is good on both
legs and he localises accurately the spot touched.
He recognises two separate points to within
three inches on the Left leg, but they have
to be many inches further before he can dis-
tinguish them on the Right leg.

Sensibility to Tickling is good on the Left leg.
On the Right it is diminished at the sole and
above the knee for some distance, and it is
nearly absent over the intermediate part of the
leg.

Sensibility to Pain is good on the Left leg, on
the Right it is diminished. On both sides he can
distinguish pinching from prickling. There is also
a retardation of the feeling of pain on the
Right side. The patient himself was aware of this
for, he says, he often pinches his leg and does not
feel the pain till after he removes his fingers.

The sensibility to pain on the Right side be-
comes about natural at the groin, but there
is a marked diminution of the sensibility on
the Right side of the penis and scrotum.

He is unable to distinguish between a test-
tube containing cold water and one containing
hot water on the Right leg. He becomes slightly
consciously of the difference in the upper part of the
thigh, but there is still a considerable diminution of the sensibility as high on the abdomen as on a level with the Pelvic brim. This condition is also limited to the Right side of penis and scrotum.

It is to be understood that, unless otherwise mentioned, the sensations of the Left side were found to be in accord with health.

**Reflex Phenomena.**

In tickling the Left sole the sensation is natural but the only muscular response displayed, is a slight extension of the great toe occasionally accompanied with its neighbouring toe. On the Right side the movement are such as one would expect to occur in health, but the patient’s sensation of the tickling is much less acute than natural as already described. The reflex retraction of the testicles can be got on both sides, after tickling the inner surface of the thigh. I fail to obtain the gluteal reflex, and I am only doubtfully successful with the abdominal.

The Patellar tendon reflex is exaggerated on both sides bend more so on the Left than on the Right. It can also occasionally be obtained on the Tibialis Anticus.

On tapping the external malleolus of the Right leg the Tibialis Anticus & Extensor Proprius hallucis contract from the Left external malleolus the Tibialis Anticus alone contracts. No other peroneal reflexes are obtainable.
There is a slight ankle clonus on the left leg. After the examination and while the leg was hanging the leg let was spasmodically pulled back every now and again.

He is a little out of his reckoning in knowing where his Left leg is placed, but quite accurate with the Right leg.
He can also form a fairly accurate opinion of the weight of different bodies with the Right leg. On the Left side weights of 1½ to 2½ lbs he can discriminate between and tell their relative weight, but 5 lbs he can scarcely lift and thinks that the weight is 20 lbs.

Electrical Phenomena. Sensation of the galvanic current is diminished in the skin of the Right leg.
The muscles contract equally and naturally on both sides, including the Left hamstrings.
The electro muscular sensibility is retained equally in the muscles of both legs.

Thickness of Right Thigh 8 m. above patella 19 ½ m.

Left = 19 ½ m.

Thickest part of Right calf 13½ m.

Left = 13½ m.
Digestive System.

Tongue is clean. Digestion good. Appetite fair and no discomfort after meals. No difficulty in swallowing. The bowels are very constive, and he has to take castor oil frequently in order to get a liquid motion. Otherwise the faces get hard and lodge in the rectum whence he has to displace them with his finger. After he has had a motion he declares the feeling of well-being to be extremely comfortable.

The finger being passed into the rectum the sphincter is found laxer than natural. Yet there is no incontinence of faces.

Genito-urinary System.

The power of erection is still in abeyance. He awakes occasionally at night with the penis erect, but it soon subsides.

There is considerable difficulty in micturating. When he wishes to perform this act, he has to stand supported, stooping slightly forward, with the left leg thrown backwards and outwards. After a time a drop of urine escapes, followed soon by a few more and latterly by a fair stream, but projected with little force. He is unable to tell when the stream flows or when it stops, save by watching it with his eyes. If he speaks the stream stops. If he change his position it also stops. In fact he cannot accomplish his object by this method in any other position.
The bladder is only partially emptied when he
senses in this way, the sensation for the necessity
of emptying, the bladder soon outside after evacuating
a small quantity.

Another method he has, of accomplishing the same
object, by assuming a sitting posture, opening his
thighs, and passing his finger into the Rectum,
when there immediately follows a full and forcible
dream of urine from the rectum. It stops after the
finger is withdrawn, and is again excited by the
same operation. By this procedure the bladder can
be completely emptied as is evidenced by the fact that
no urine is drawn off in passing an undecorbed
Catheter into the bladder. Neither by this method,
can he tell when the urine is being evacuated, unless,
he watches the process.

The left testicle is atrophied, consequent on the sup-
pression described in the previous examination.

His other joints and organs present no abnormality.
### Tabular view of Pollard's

**December 1880**

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<thead>
<tr>
<th>Phenomenon</th>
<th>Left Leg</th>
<th>Right Leg</th>
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<tr>
<td>Motor Phenomena</td>
<td>Voluntary Muscular</td>
<td>Much diminished</td>
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<td>Sensory Phenomena</td>
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- **Genital functions**: Absent
- **Urinary do**: Difficulty in micturition
- **Rectal do**: do do defaecating
- **Anesthesia and Hypoesthesia**: abdominal bands
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<tr>
<th>Condition at Different Periods</th>
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<tr>
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19 1/2” 19 1/2”
12 1/2” 13 1/2”
Treatment.

No special treatment was employed till January 7th 1881, when the patient had administered to him small
dose of Iodide of Potassium,

\[ \text{R - Pot. Iodid } 3\frac{1}{2} \]

Fenn's gin at 3 fl.

Syr. Aconitum 3 fl.

Aq. @ 3 fl. Mixture.

Sig. 3 fl. to be in die.

He continued taking this until his removal to Manchester hospital (Feb. 25th). I have not been able to procure
particulars of the course of treatment pursued in Manchester hospital, further than that he had large doses of Iodide of Potassium. Mercureial injection was also tried till mer-
curialism was developed. He made rapid progress in recovery after the last method of treatment was employed.

All treatment has been practically discontinued since last May (1881).
Diagnosis

A Syphilitic Gummatus Tumour situated in the substance of the Left half of the Spinal Cord, at the Upper part of the Lumbar enlargement.

Brown–segward may now be considered to have fully established the method of recognising a one-sided lesion of the spinal cord, by the very definite series of symptoms presented during life. The case I have detailed ranks itself as one of those whose symptoms present all the evidences for attributing the lesion to a situation on one half of the cord. The reasons for the above

Diagnosis will be discussed under the following heads. I Clinical Diagnosis, II Topographical Diagnosis, III Pathological Diagnosis.

I Clinical Diagnosis.

The first symptom that presented itself to the patient, was a feeling in the Right leg which, with some hesitation, he called numbness, as otherwise he could not describe the sensation. As was afterwards shown upon examination the feeling was due to interference with the conduction of the pathic, and thermic senses. Then the genital, urinary, and rectal reflexes, became successively involved, followed soon by great motor weakness of the Left leg. In the various examenation recorded there is always presented
the same picture — sensory abnormalities of the Right leg, and loss of muscular power on the Left leg, while there was always retained sensation intact on the Left leg and muscular power on the Right.

**Fig 1.** In this diagram the perpendicular lines in the Left leg represent the motor paralyses. The transverse lines in the Right leg represent the sensory changes. It is supposed to represent the condition of the patient when the illness was at its worst, and therefore the hyperaesthetic (+) and anaesthetic (−) bands are introduced.

As will be afterwards shown, these symptoms fully accord with interference of the Left half of the cord, or as much as the motor tract in the cord pursues its course on the same side of the body that it innervates, therefore giving rise to paralytic phenomena on that side. On the other hand the sensory nerves crossing immediately on their entrance into the cord, the nerves from the Left leg escape while those of the Right leg are interfered with after they have crossed.
From the Clinical standpoint therefore, the case may be regarded as an example of hemi-paraplegia spinalis.

II Scolio-raphic Diagnosis

1st In the Longitudinal Axis of the cord.

From the fact that early on in the illness there was interference with the urinary function, which has persisted, it is reasonable to conclude that the lesion must have occupied a situation in the neighbourhood of the automatic centre for the bladder. It is true that the urinary disturbance might have arisen from interference with other parts of the reflex arc, than the automatic centre, but from evidence to be deduced later on, it will be apparent that the disturbance was undoubtly due to this centre. Physiologists agree in attributing the situation of the automatic centre of the bladder to the lumbar enlargement. It has further lately been localised more particularly in the large bipolar ganglion cells of the vesicular column of Clarke at its lower end. This column begins to appear in the upper part of the lumbar enlargement, and is continued to the upper part of the dorsal region of the cord. Its function is supposed to be the innervation of the internal organs; representing an automatic action, presiding therefore over the gastro-intestinal tract and the genito-urinary processes. In the medulla it may, for several reasons, be considered to be re-
presented by the nuclei, at the origin of the Vagus, glossopharyngeal, and part of the spinal accessory nerves. (Ross' Diseases of the Nervous system vol ii p. 145 and 16.) Assuming then that it does so preside over the gastro-intestinal tract, the Rectal disturbance would point to interference with the lower end of the column, in the immediate neighbourhood of the genital and urinary centres.

A further reason for placing the lesion at this height is the fact that as a rule the sensory disturbances on the right side appeared only in the tract of nerves derived below the 12th Dorsal. The 12th Dorsal nerve on both sides presented at the time when the ailment reached its maximum intensity, symptoms of being actively interfered with. At that time alternating hyperaesthesia and anaesthesia were found in the course of their distribution. The 12th Dorsal nerve enters the spinal cord at the upper part of the Lumbar enlargement, and lower part of the dorsal region. Thus we find as the lesion advanced and occupied its greatest space as shown by the symptoms, before it crossed the nerve on the left side, was affected to a greater extent than the Right nerve, before it crossed. The fibres of the Right nerve being affected after they had crossed in the cord. With the symptoms of the remission of the lesion, the phenomena evidenced by the 12th dorsal nerves disappeared, and their areas of distribution presented no longer any abnormality.
Tenderness has been elicited on several occasions, by percussion over the 11th and 12th dorsal vertebra and the 1st lumbar vertebra, a position corresponding usually with the situation of the lumbar enlargement.

There is thus evidence that in the longitudinal axis of the cord the lesion occupied the lumbar enlargement. That, further, it was in the upper part of this enlargement, corresponding with the lower end of the vesicular column of Clarke. Additional proof of this situation is afforded by the fact that the 12th dorsal nerve entered immediately above the lesion. The longitudinal extent of the lesion could not be great seeing that the 1st lumbar nerve of the left side was unaffected crossing evidently immediately below the level of the lesion. The extent of the lesion must therefore have only occupied a space between the 12th dorsal nerve and the first lumbar nerve.

2nd. In the transverse axis of the cord.

I will first endeavour to show that the lesion occupied but one side of the cord and that the left.

If it be kept in mind that the only paths in the cord that are known with anything of certainty, are through the posterior columns for pain in the central grey matter for the opposite side of the body, and motor impulses in the antero-lateral columns (perhaps solely in the pyramidal tract) for the same side of the body, we shall get a clearer
idea of the localisation of the lesion. Taking
the legs alone as showing more clearly the relative
value of the symptoms upon this point, we find
the abnormalities in the stages antecedent, and
subsequent to the period of the most intense nervous
disturbances to be.

Left leg  Right leg
Motor Paralysis  Interference with
Diminished touch

During the period of most severe symptoms there was
in addition to these manifestations more profound
interference with the sense of touch. In the above
figure all the afferent nerves entering on the right side are
shown interrupted in the left half of the cord, while
the left ones escape in right half of the cord. The motor
path on the right side pursue their course uninter-
rupted, while those of the left are interfered
with.
In the foregoing diagrammatic form I have represented the lateral and posterior columns, and the central grey matter with the various peripheral connections that are with certainty known. I have left out several abnormalities, and my reasons for not including them are, that the courses of their healthy manifestations are not known, or that they necessitate a compound mechanism, requiring both sensory and motor nerves for their completion, and the nature of their abnormalities will be discussed with the individual symptoms.

As those paths that are known, occupy parts distributed over the entire area of half of the cord, it follows that in judging whether both sides are affected or not the main evidence rests with them. There being no evidence that the right half was affected, the probability is that the left side only was diseased.

I will next consider the situation of the lesion in the left half of the cord.

To illustrate the manner of invasion and the effects of the disease I will employ the illustration given on the following page. This illustration is a representation of a section of the spinal cord taken on a level with the upper end of the lumbar enlargement. It is copied from T. Russ' work on Diseases of the Nervous System Vol. II p 55.
A lesion situated in the central grey matter at + would interfere with the conduction of the sense of pain. Increasing in size it would press on the vesicular column of Clarke (v.c.) giving rise to the genital, vesical and rectal disturbances. Pressing outwards it would interfere with the posterior part of the lateral column and more particularly with the pyramidal tract (p.t.) giving rise to the motor paralysis, and afterwards in consequence of this interference with the pyramidal tract, secondary descending degeneration causing that rigidity which has latterly affected Pollard's left leg. As the tumour increased in size it showed evidence of interference with the posterior columns producing joint diminished ability to
recognise separate joints, then when it had reached its largest, diminution of the sense of touch, and of muscular sense, in the right leg. The pressure at this time evidently slightly affected the opposite side, so there was interference with the tactile sense, in so far as there was diminution in the ability to recognise separate joints (page 5).

As the tumour receded it left the posterior columns more free, and in consequence permanent improvement of the tactile sense ensued. Notwithstanding this recession of the damage affecting the pyramidal tract, central grey matter and ventral column of Clarke, has remained more or less permanent.

It is to be noted that at no time did there appear interference with the anterior horns or columns, seeing that the trophic and vaso-motor junction presented no abnormality. The paralysis, further, was anaesthetic in its character and not atrophic, as is shown by the electrical reaction of the muscles being normal, and the bulk of the muscles being maintained. What little diminution there is in the left calf can be accounted for by simple disease.

Meditating against this central localisation of the disease, is the extreme rarity of recorded cases of centrally situated syphilomata. Nevertheless when the initiaIatory symptoms, and the course of the case are taken into consideration, the burden of evidence points to the central localisation. The general symptomatology of recorded syphilitic affection of the cord, commences with prodromal symptoms, referable to the meninges,
the nerve roots or the exterior of the cord. Thus
pains in the back localized it may be in some region
of the column, and increased by pressure. Neuralgic
pains in the limbs with other abnormalities as tingling
formation to, stiffness, rigidity or cramps in the
muscles. Then follow upon these the more serious
symptoms of paralysis to.
Here on the other hand there were no such prodrional
symptoms. Even when the disease had considerably ad-
vanced there was no tenderness along the spinal column,
indicating that the meninges were intact. When this
symptom did appear, it was at that time when
the evidences pointed to the exterior of the cord being
affected, and which had been preceded by evidences of
the interior being interfered with. On the recession of
the illness central disturbances persisted while those
indicating interference with the periphery and meninges
to a great extent disappeared.

III Pathological Diagnosis.
1st Constitutional Evidences of Syphilis. I am bound
to admit that information upon this point is
somewhat scanty. There is the fact of cicatrices in
the left groin. The patient's explanation that it
followed upon a swelling of the testicle caused by
scurf, is not to be credited, seeing that the
lymphatics of the testicle pass up the cord into
the lumbar glands, and not into the inguinal.
He admits contracting a gonorrhoea subsequent to this,
and his manner indicates a desire to minimise the results of his immorality. Further knowledge of sequelae, derived from personal examination, and interrogating him, can only be found in the falling off of the hair, which happened several years ago and came off in considerable quantities.

The recovery that has taken place excludes all other forms of disease. Especially so, seeing that the illness yielded to anti-syphilitic treatment. The specific nature of the lesion was not at first recognised but after the Soda of Potassium was employed, improvement gradually took place, and steadily continued.

2nd Form of the Lesion. Syphilis manifests itself in attacking the cord, as a granulomatous affection, in two forms viz: a diffuse infiltration; and a circum-concentric deposit (tumour), the latter form often being multiple. The diffuse infiltration as a rule takes place in the meninges or the periphery of the cord. As I have shown this illness began in the centre of the cord. The symptoms showed a definite set of manifestations that could only be accounted for by a lesion, limited in extent, and defined in form. For these reasons we may exclude the possibility of the affection being diffuse in its character or multiple in its distribution.

Again, all syphilitic diseases of a granulomatous nature, when separation sets in, leave a cicatrix which necessarily interferes with the function of the part. Hence recovery cannot be perfect, and in this manner the partial recovery exhibited by Pollard.
is accounted for.

While syphilis of the cord is far from being rare, all authorities testify to the rarity of the form which I have attributed to this case. Thus Heubner throwing doubts on a case of centrally situated syphilitic nodule recorded by Wagner, says, "I have been unable to find any other observation of syphiloma developed in the interior of the cord recorded in the literature of the subject." (Stremser's Encyclopedia, Vol. XII, p. 338.) Heb admits the occurrence of the syphilitic tumour amongst the class of intramedullary tumours of the cord, but at the same time testifies to their rarity. (Stremser's Encyclopedia, Vol. XIII, p. 756.) Lancereaux states occurrence testifying to acquaintance with three cases, two of which he admits are doubtful, — one of the doubtful cases being that of Wagner referred to by Heubner. (Lancereaux's Treatise on Syphilis, New, Kydembourg Loz., Vol. II, p. 85.)

By the exclusion of other disease the same diagnosis is arrived at.

The following diseases whose symptoms might have shown a resemblance to those in Pollard, are excluded on other grounds.

1. Other syphilitic affections, as scleritis, adhesion and opacities of membranes, syphilitic affections of the bones etc. are excluded: (a) on account of the limitation of the lesion; (b) on the evidence of the interior being primarily affected.
2. Subacute central myelitis would not be limited so definitely to one side of the cord. Nor would it progress to the interference of those functions, which was observed at the height of this illness and then outside leaving the functions so little impaired. The paralysis would have been atrophic in character and not spastic.

3. Haemorrhage into the cord would assume a more rapid character compared with the comparatively slow and steady progressive character of this case. There would have been anæsthesia of the nerves at the level of the lesion, and the paralysis would have been atrophic in its nature.

4. Simple softening of the cord (Myelomalacia) which may take place at any part pursues a decidedly unfavourable course. It would have become more general in its manifestations, invading both sides of the cord and the anterior horns.

5. Other tumours of the cord. Erb says "Intramedullary tumours except syphilis pursue an absolutely unfavorable course." (Yemmenei's Oeye. Vol. XIII p. 756.)
Analysis of individual symptoms with

I. Motor Mechanism.

Paralysis depending on diseases of the spinal cord, occurs in two typical forms, viz., where the muscles are flaccid and undergo atrophy (atrophic paralysis), and where they become tense and rigid, but remain well nourished (spasmodic paralysis). The former variety occurs in diseases affecting the anterior horns of the cord, as Infantile paralysis. The latter in disease of the pyramidal tract, as in Lateral sclerosis. There may occur a mixture of both kinds in the same individual, as in Amyotrophic lateral sclerosis.

In Holland, the paralysis has assumed an undoubted spasmodic character. His left leg is of good bulk, well nourished, offers resistance to passive movement, has the tendon reflexes increased, and presents no alteration of the electrical reaction, all these being evidences of degeneration of the lateral column, and more particularly of the pyramidal tract.

The individual muscles paralyzed can only be made out by examining the movements of the leg. All the muscles concerned in these movements appear to be affected to a greater or less extent. Those acting on the hip joint to a less extent than those acting on the other joints of the limb. There is also much less tension in those hip joint muscles, seeing that the passive movements of the joint are performed with more facility. The muscles supplied by the great secatic and its branches exhibit
the paralysis most markedly. This is specially the case with the hamstrings, whose power of contraction is very weak, compared that of its opponent (quadriceps).

It would be unfruitful to go into a detailed account of the condition of each muscle, and I will therefore only point out that the muscles that can be clearly demonstrated to be affected are those whose nervous supply is derived from the lumbar and sacral places. It would be difficult to make out whether the muscles supplied by the inferior dorsal nerves are affected, but so far as I can make out there is no evidence of their paralysis.

II Sensory Mechanism.

All sensory impulses enter the cord by the posterior roots, and pass directly through the posterior external column into the posterior cornua, and cross almost at once to the opposite side. The paths of conduction for the various sensations in the cord have not yet been established. There is no doubt that the various impressions are conducted by paths in different parts of the cord. The only paths clearly made out, are those for pain in the central grey matter, and touch in the posterior columns. Temperature was supposed to be conducted by the posterior columns as well. But recent experiments localise it in the lower animals in the lateral columns in the dorsal region. Gowers suggests the possibility that this path may be just in front of the pyramidal tracts, because, in a case of crushed cord, he found a small area
exhibiting slight ascending degeneration. Because of the degeneration exhibiting an ascending process, it points to the affection interfering with the conduction of afferent impressions. (Powers Diseases of the Spinal cord, 2nd ed., pp. 157-16)

Brown-Séguard asserts that there are eleven kinds of nerve-fibres in the spinal cord. Amongst these, he includes those for tickling as being distinct from touch. (Lectures on the Diagnosis and Treatment of Functional Nervous Affections, p. 11)

In Pollard there was exhibited the fact that tickling the right sole only produced the sensation of touch. But if this subdivision be accepted there ought also to be the recognition of one class of nerve-fibres for separate points. It is to be noted that both in the early and late stages of Pollard's illness, the difference between the recognition of simple touch, and separate points was very marked. The former was readily detected and accurately localized, while the latter was grossly impaired. Yet books generally describe the testing for separate points, as a method for estimating the condition of touch. Doubtless when there is no sense of touch there could be no means of recognizing separate points. But it does not follow that inability to recognize separate points indicates abolition of the sense of touch. The same may be said of tickling, for I should think that were the sense of touch abolished that of tickling would also be absent. I would therefore be inclined to suggest that separate points like tickling require certain nerve-fibres for conduction, in addition to those for touch pure and simple. That this suggestion may not be considered an over-refinement, I may state that in
treating, in a muscular sense, I shall have occasion to show, that taking separate points as a guide, a discrepancy has arisen in calling cases anaesthetic that were really not so.

The sense of pain has, to a great extent, returned, but its conduction is still retarded, indicating that some affection of the grey matter still exists.

The sense of temperature is still much impaired. There is nothing in this case contradictory to Burrows suggestion; rather the reverse, for we have seen the pyramidal tract to have been much impaired, and this afferent tract being in the immediate neighbourhood could suffer likewise.

There is an absence of one very important symptom in this case which occurs in most recorded cases of unilateral lesion of the cord, namely **Hypoaesthesia** of the affected side below the level of the lesion. Authorities are by no means agreed as to the cause of this hypoaesthesia. Erb says, "It is in part referred to the secondary inflammation of the cord following the wound, and the greater irritability of the sensitive tracts caused by this inflammation; and in part to the withdrawal of certain controlling influences which hold the irritability of the sensitive nerves within bounds and whose tract remain on the same side of the cord." (Jenner's Practice: vol. XIII p 656.) Amplicari attributes it to injury done to the opposite half of the cord by the blow, involving the sensory nerves after they have crossed. (Physiologie du systeme nerveux: vol. I p 142.) St. Burrows suggests that the optic thalamus being a sensory centre as well as a reflex inhibitory
centre, deprived of stimulation from the sensory nerves that have been injured, gives rise to a more intensified sensation referred to the sensory nerves that are intact. (Samuel vol II 1879 p.929.) Brown-Sequard, among other causes, suggests this paralysis of the vasomotor nerves. (Samuel vol II 1869 p.320.) Sfar as the negative evidence in my case goes it rather supports the last explanation. The symptom of hyperesthesia is nearly always present in recorded cases, whether from a tumour or from a blow, and always occurs on the side of the lesion. Accompanying the hyperesthesia there has generally been found an elevation of the temperature also limited to the side of the lesion. There was no evidence of vasomotor paralysis (the cause of the elevated temperature) in污染 left leg. This was possibly due to the vasomotor nerves in the cord pursuing a course either in the anterior columns, or anterior part of the lateral columns. Had the hyperesthesia in other cases been due to a congestive condition either in the same, or the the opposite side, there is no reason for supposing any case exempt from such a condition. Whereas as we have already shown, the burden of evidence has tended to point to exclusion of the anterior columns, and confirms from inference.

The bands of hyperesthesia and anæsthesia I have already shown to be due to the twelfth dorsal nerve falling within the range of the lesion. A similar incident to the hyperesthesia, alternating with the anæsthesia, and natural sensation, I have not seen elsewhere described. The variability of the
pressions produced was probably due to the difference in the amount of pressure exerted on the various filaments, producing irritation of the nerve or abolishing its power of conduction. The normal sensations intermingling with these, would be caused by the eleventh dorsal and first lumbar nerves being partly distributed to this area.

**Muscular Sense.**

This sense in the case of Ballard is of considerable importance in, as much as it presents features at variance with the condition reported in other cases of unilateral lesion of the cord. At that time was a want of accurate knowledge regarding the manifestations of this sense it will be advisable first to consider its nature.

The sensations by which in health we judge the weight of bodies, the amount of resistance presented to our muscular exertions, the quantity of energy necessary to be employed in order to place our limbs in any given position, with the ability to recognise in what position they have been placed, depend upon two conditions affecting our consciousness, namely: Motor Feeling proper and Sensation proper. "The one is associated with energy passing outwards the other with stimulation passing inwards; the two facts mingle together in the stream of mental life, but are yet of a widely different nature." (Professor Bain in "Senses and Intellect" 3rd ed: p 94.)

The sensation described by Professor Bain as Motor
Feeling is a very important factor in the constitution of the muscular sense. By omitting to consider it, many erroneous statements regarding disturbances of this sense have occurred.

I will state, as succinctly as possible, what appears to me to be the part played by these two factors in constituting the muscular sense.

A. Motor Feeling. According to Bain, who is the chief exponent of this idea, motor feeling is a "sensibility accompanying muscular movement, coinciding with the outgoing stream of nervous energy, and does not as in the case of pure sensation, result from any influence passing inwards by encarrying or sensitive nerves." p. 121.

Motor feeling is the result of experience. We are conscious before any required action is performed, how much energy will be necessary to accomplish the action. When energy is being liberated, we are conscious at the time how much energy is being expended, independent of any sensation conveyed from ongoing nerves. Being conscious of this liberation of energy, we can voluntarily regulate the amount.

The above may be illustrated in the following way: two balls externally identical are placed before me. They weigh 3 lbs., one weighs 1 lb., and one weighs 10 lbs., but I am not aware of this difference. I proceed to lift the four 3-lb. weights, one after the other. Before I lift the fourth, I have become aware of the amount of energy necessary to expand, so I at once pick it up, no time being lost in regulating the amount of energy. So likewise I suspend at once the same effort in raising the
1st weight, but discover from the effect produced on my hand and arm by means of the ongoing sensory impression that I have liberated more energy than was required. On the other hand, on coming to the 10th weight I find that the amount of energy previously found sufficient will not raise the object so that I have consciously to liberate the required amount, regulating it according as the centripetal moves inform me of the result.

In paralysis, the past played by motor feeling leads to an error of judgment in the following way. When the limb is partially paralysed, light weights being lifted without much conscious effort, are approximately estimated by the ongoing nerves revealing the fact that not much impression has been made upon them, while the exertion necessary to lift them is not sufficient to direct the attention to the sense of muscular effort. When a weight which the limb is powerless to raise is placed upon it, then the patient finds it necessary to exert himself to the utmost. He therefore from this higher centre conscious discharge much energy, and is forced to take cognizance of this. But the outgoing stream, after he has recognised its discharge, is lost on the way, and the patient aware of how much "virtue went out of him", attributes to the weight properties which by experience, he had become accustomed to associate with the known amount of nervous discharge.

This is borne out in the case of Collard where the description on page 22 is as follows. "On the left side (leg) weights of 1st to 2nd he can dis-
cumenate between and tell their relative weights, but 5 lb. he can scarcely lift and thinks that the weight is 20 lb."

(B) Sensation Proper. This depends upon centrifugal nerve for its central recognition. A stimulus is originated in nerve terminations, which are distributed in various tissues. From thence the impressions are conveyed in a path following the route taken by other sensory impressions, namely, the posterior roots, then crossing to the opposite side of the cord upwards in the posterior columns and so to the brain. These various nerve fibres may have their peripheral extremities in connection with the skin, joints, periosseum muscles and their fasciae. I consider that all of them may take part in producing the muscular sense.

The origin and course of the sensation proper as above described is supported by the following fact derived from pathological and experimental data. In the first place, there is the anatomical fact that Amst found in the muscles (in all classes of animals) fine nerve fibres which twine around the sarcolemma, and appear to end in it, and which he regards as the sensory nerves of the muscle. Hauque holds that the corpuscles of Vater found in the sheaths of muscles in the periosteum and in the vicinity of the joints perform some at least of the functions which are generally attributed to the
so called "muscular sense." [Editor's note: Excerpt from Jameson's Textbook of Medicine, p. 233]

Passing upwards to the posterior root we find that "when a galvanic current is applied to the muscles of the limit of a frog in which the posterior roots of the nerves of this limit have been divided no trace of pain is produced, and all the other causes of pain are also unable to cause it when applied to the skin or the muscles." (Brown-Séquard, Physiology of the Central Nervous System)

The association of the sensory part of muscular sense with the conduction of other forms of sensation, in the spinal cord is well shown in the following case, of which I quote a condensed report.

During life the patient exhibited complete anaesthesia in upper and lower limbs. Sense of position and passive movement absent in all limbs. Voluntary movements of all kinds powerful and correct when guided by the sight. Eyes being shut he can raise his foot to a given height.

In the autopsy among other conditions not essential for the purpose quoted here, there was found, destruction of Posterior columns in lower half of cervical medulla and above this gray degeneration. In the dorsal part slight atrophy and increase of connective tissue. The lumbar part normal. Anterior columns everywhere quite uninjured and normal. (C. Jameson: Br. Med. J. 1873, p. 89.)

To make the evidence of the association of the sensations in their conduction in the spinal cord complete I will next quote a case showing that the muscular sense,
conducted by sensory nerves, across the cord. Unfortunately no examination of the spinal cord took place in the autopsy, as the lesion was supposed to be in the brain where, it is unnecessary to say, it was not found. From the symptoms during life no doubt can be now expressed as to its having a unilateral lesion of the cord.

The patient was a woman in whom there was complete unquestionable anaesthesia, and loss of muscular sense on one side of the body. The evidence of this is well shown in the fact that unless her eyes were directed to her baby, she could not tell whether the child was sucking or not. While carrying her child in her arm if the mother's eyes were directed from the child it was in danger of falling, thus showing a loss of the sense of position, and an inability to feel the weight. There was no loss of muscular power on that side but paralysis of the other side (Reported to Dr. Chas. Bell by D'Tay and quoted by D'Brunswick-Segard in Lancet Vol. 1864 p 822.)

Passing to the brain we then find plenty of evidence of the association of tactile sensibility and the sensory part of muscular sense.

Ferrier in his experiments shows that destruction of the hippocampal region (hippocampus major and parahippocamp) produces in the monkey tactile anaesthesia and loss of the sense of position, in the opposite side of the body. The symptoms thus produced in the monkey were similar to those observed in patients suffering from central hemianaesthesia. In a case quoted by Ferrier there are present of resemblance.
to those cases of spinal affections which I have previously referred to. Here a woman is described who could move her hands well under guidance of the eye, with her eyes shut she could put her hand on her head. If instead, her hand was held, she evidently made the effort, and although the hand was not moved, yet she had the impression that she had accomplished her object, and that her hand was on her head. The sense of position was gone. (The Functions of the Brain by Dr. Ferrer p. 175 et seq.)

In those cases of hemianesthesia the minor part played by "motor feeling" and the gap caused by the abolition of "sensatio propria" in the constitution of muscular sense is well seen. It is to be observed that the sense was not entirely abolished, in as much as the patient knew when muscular effort was being made. It further shows how accurate were the views arrived at by Sir Horace Hamilton while reasoning upon this subject, and how pathological facts bear out what I presume was a hypothetical conclusion.

He says "It is impossible that the state of muscular feeling can enable us to be immediately cognizant of the existence and degree of a resisting force. In the contrary, supposing all muscular feeling abolished, the power of moving muscles at will remaining, if I hold that the consciousness of the mental motive energy, and of the greater or less intensity of such energy requisite in different circumstances to accomplish our intention, would of itself enable us always
to perceive the fact and in some degree to measure the amount of any resistance to our voluntary movement, how that the concomitance of certain feelings with the different states of muscular tension renders this cognition not only easier, but in fact attracts it to our attention (Davies' Lessons p.99).

Muscular sense is therefore different from other sensations. These 2 factors "motor feeling" and "sensation" combine to constitute it. In health they are so associated that they "move together in the stream of mental life" producing a sensation which is brought to our consciousness in its entirety. The one factor (motor feeling) may be said to take cognizance of the cause while the other informs us of the effect, of a voluntary movement.

The following diagram illustrates the course and course of the Muscular sense.

Fig. 4. C. Centre of consciousness
S.C.S.C., Sensory centres
M.C., M.C., Nerve to
S.P., S.P., MP, MP Sensory motor path in the cord.
M.N., M.N., Motor nerve going to M.M.
M.N.
S.N., S.N., Sensory nerves with filaments distributed to joints, muscles.
The arrows indicate the path by which muscular sense is conveyed.
The foregoing explanation of the muscular sense is not in accord with opinions expressed by several authorities. For on the one hand we find the motor fulvig factor objected to; and on the other the course of the peripheral sensation to be other than I have described. It will be necessary therefore to devote a little consideration to the grounds on which objections have been raised.

A) Objectives to the Motor Feeling.

The motor fulvig, as described by Professor Bain, is disputed by Dr. Ferrier. According to Ferrier all sensations connected with the muscular sense can be accounted for without admitting the motor fulvig. If any one has a sense of muscular effort which has not been expanded in the part to which his attention was directed, it is because other muscles of the body were called into play, and the whole sensation was made up of parts distributed, it may be, over the whole body. He illustrates this by stating that, if one contemplates performing any action and instead of doing it, he simply "make believe" that he does so, he is only conscious of the "make believe", provided he closes his glottis, and expends the force in fixing the respiratory muscles. The sensation of "make believe" will not be experienced if the process of breathing be continued. This respiratory factor, he goes on to state, has been overlooked in attributing the consciousness to the outgoing current. "In the contraction of the respiratory muscles there are the necessary conditions of centrifugal impressions, and these are capable of originating the general sense.
of effort. When these active efforts are withheld no consciousness of effort ever arises, except in so far as it is conditioned by the local contraction of the group of muscles, towards which the attention is directed, or by other muscular contractions called unconsciously into play in the attempt." (Manual of the Brain, p. 223.)

Here then we have the weighty opinion of Ferrer exercised against the theory of Dr. Bain. He attributes, by the by, the first enunciation of the outgoing sensation to Bain, whereas will be seen the same idea is present in the quotation given before from Sir W. Hamilton. Instead of the phrase "motor feeling" Hamilton used the term "motoric faculty".

I do not think Ferrer is warranted in basing a radical objection to the motor feeling theory on the condition observed by him. Even granting the feeling produced by the "make belief" of an action, we still have the consciousness quite distinct that the action did not take place. A general feeling is not convertible into a local sensation. And when a patient exerting himself to move his paralyzed limb, his sense of effort is not a result conveyed to him by sensory nerves stimulated by the contraction of muscles all over the body, but is the consciousness of a discharge in the tract that usually produces this desired result. The concomitant contraction of the other muscles is a result observed always in producing any great effort, and bears a certain ratio to the central discharge of energy equally in disease as in health.
Take into consideration the case quoted by Ferrier himself (of hemi-anasthesia referred to on page 52) where there was tactile anaesthesia with loss of sense of position. When that patient wished to lift her arm there was no peripheral sensation whatever yet she must have been conscious of the sense of effort, else she would not have known that the movement had been accomplished. Even when the hand was held and she had performed what she considered a certain movement, I doubt not that there would have been found a contraction of the required muscles. Further when the patient's hand was held it could only have been the motor feeling that led her to believe that the hand had been moved to the desired position.

From these considerations I do not think that Dr. Ferrier has succeeded in invalidating the doctrine laid down by Professor Bannister.

**(B) Objections to sensation proper (of muscular sense) being conveyed by the ordinary sensory paths.**

Against attributing the course of the muscular sense to be along with the sensory nerves in the posterior roots and the usual sensory paths in the cord, there is the assertion of Dr. Brown-Séquard that the sensation is transmitted along the voluntary motor paths in the newer and spinal cord. (Lectures on the diagnosis of unilateral lesions of the cord. Lancet 1869 Vol. ii. p. 3.) His reasons for this are chiefly because he found in unilateral lesions of the cord interference with this sense on the paralyzed
side. Later authors in their articles upon unilateral lesions of the cord have unquestioningly followed him in stating that the muscular sense is affected on the side of motor paralysis. (Erb, Ross, Comnée, Bramwell re.)

The term "muscular sense" as applied to this condition is not sufficiently explicit as there is a difference in its manifestation from that which occurs in locomotor ataxy, hemianæsthesia re., the use of the same term in both cases is likely to lead to wrong inferences as I consider it has led Dr. Brown-Séquard, when he represents motor paths as sensory conductors.

When the muscular sense (as tested by weights) presents any abnormality in a limb, where there is motor paralysis, and no disturbance of the sense of touch, this abnormality is due to an error of judgment arising from the part played by the motor feeling factor, and not on account of interference of centrifugal impressions. I have explained on page 148 how one of the manifestations of abnormality in my case occurred. Here we saw that Palladis' knowledge of weights was wrong, because he drew his conclusions from the consciousness of effort chiefly derived from the consciousness taken of a central discharge. This explanation holds good in Brown-Séquard's cases, for there is no reason for doubting that the muscular sense abnormality in Palladis
In the clinical notes on page 22 I state, "He is a little out of his reckoning in knowing where his left leg is placed." I have again tested him carefully on this point, and find that although he does not point his finger as accurately towards his left great toe as towards his right, yet he has a fairly accurate idea of the position of the leg, seeing that when asked to place his leg in the position that once while I had passively placed it, he swiftly put it in almost the same position. The following explanation will probably account for slight abnormalities of the sense of position. (On opposite page)
Paralyzed leg was of the same nature as in the paralyzed leg of Brown-Séquard cases. The temporary alternation of muscular sense in Pollard's right leg was of the nature of an interrupted centrifugal impression, corresponding to that occurring in locomotor ataxy, hemianesthesia &c. (see page 10). I am therefore of opinion that had the distinction between the component parts of muscular sense been kept in view, clinical observers would have found in the application of the "motor feeling" an explanation of the phenomena observed by them where the abnormal muscular sense was not associated with other sensory disturbances, but appeared simultaneously with the motor paralysis.

While in the foregoing manner the loss of the sense for discriminating weights is accounted for, there still remains unexplained the abnormality of muscular sense evidenced by the loss of the sense of position and of pressure. (See remarks on the opposite page.)

In regard to the loss of sense of position, these has to be taken into consideration what occurs in the muscles of a healthy person when one of his limbs is passively moved. In all such movements there is necessarily a relaxation of certain muscles and a contraction (or a contraction) of others, whether vital or mechanical; it is much unprofit here, although I believe it to be vital and more is loss of a tonic nature. In their alterations of the condition of the muscles certain sensations are.
sound to result in the tendons, ligaments, the muscles themselves re, slight it may be, but nevertheless tending to form a part of the whole muscular sense. Now in paralysis this normal condition is departed from. In the one case the tension of the muscles become increased, and increased force is necessary to move the joints; in the other, the muscles are more flaccid and less force is necessary to move the joints. Here then there is a divergence from the normal condition, and such a divergence must necessarily give rise to a deviation from the normal sensation in passive movements, and hence the interference with the ability accurately to recognize the position in which the paralysed limbs are passively placed.

The abnormality of the sense of pressure if there really was such is more difficult of explanation. In the constitution of such a feeling the skin plays an undoubted part, yet are we to suppose that sensation from the skin is also conveyed by motor paths? Whether the increase or decrease of the muscular tension as the case may be, affects the appreciation of pressure I cannot determine, all I can say is that after repeated and careful testing in Pollard, I can detect no fault in the appreciation of pressure in either leg.

Admitting the propriety of the plan of muscular sense I have laid down, it is natural to ask, why was there not a loss of the muscular sense coincidently with the anaesthesia in those cases quoted by Brown-Séquard?

In reply to this I am constrained to throw double on the record of those cases, in so far as the tactile sensibl
area is concerned. In the majority of his cases tactile
anesthesia was reported to be present from the evidence
of the patient's inability to distinguish between separate
points. I have already dealt with this question and I
must again repeat that it is no true guide. In Pollard
I recently tested him again for this sense and I found that
when I touched him as lightly as possible on the leg, with
a frizn of cotton, he immediately recognised the impres-
sion and localized it quickly and accurately. Yet on the same
parts two points had to be more than eight inches apart
before he could tell that there were two. It is further
to be noted that in the many cases of unilateral lesion
recorded the mischief was due either to stabs, fractures of
the vertebra, tumour hemorrhage re and that these could
not likely be an exact division of the cord. In the case
of injuries the internal parts of the posterior columns
are strongly protected by the spinous processes. So that
when there was the least sensation discernible, there must
have been a path for its conduction. Seldom if ever does
the description of tactile anaesthesia in these cases show
such a profound anaesthesia, as in those cases where the
loss of muscular sense accompanied the anaesthesia, as in
Cases of Cardial anaesthesia, the case of Dr. Chas. Bell referred to
on page 51, that of Dr. (page 50) when the patient felt as
if floating in air. A weighty and I think inescapable
objection to the statement that the muscular sense is trans-
mittet by the motor nerves is found in this condition
when present in locomotor ataxy. Here the loss of mus-
cular sense is associated with tactile anaesthesia, and all
with motor paralysis. For instance, in a case of advanced locomotor ataxia at present under observation, when there is retention to a considerable degree of the feeling of pain and temperature, the sense of touch is almost abolished and the muscular sense quite gone. This was well illustrated while examining the condition of the muscular sense, when Icing a stroking containing a three pound weight over the pendent leg, the patient seeing the leg about and did not know that there was even anything touching it. After I had shown him the weight, and he had again closed his eyes, he lifted his leg several times, and was not sure but that the weight was still there although I had removed it.

Upon this point Dr. Ferrer says "As a general rule diminution of tactile sensibility coincides with impairment of the muscular sense. But there are certainly cases in which the impairment of tactile sensibility does not proceed pari passu with the impairment of muscular sense. These peculiarities in the conduction of different classes of impressions are not quite satisfactorily accounted for; but on the other hand there are no pathological instances of abolition of the muscular sense without greater or less impairment of tactile sensibility. The facts of pathology and experiment tend in the opposite direction when the posterior roots of the spinal nerves are cut as in Bernardo comparison the phenomena are such as would coincide with the abolition of muscular sense. In pathological cases in which tactile sensibility is entirely abolished the muscular sense is also abolished. Condition
Assembling motor paralysis results though the power of movement is not in reality destroyed for the limbs may be moved under the guidance of the eye, though all sense of movement is quite annihilated." (Tomonin of the Brain). p. 52).

Turning now to the condition of the muscular sense in Pollard, we find it stated that "he is now unable to tell in what portion his legs are placed." Sense of weight is now entirely abolished in both legs. At the same time, on the right leg "he cannot always tell whether is being touched and when he does know it, it takes some little time for the impression to be recognized." There was also evidence that the ability to distinguish separate points was impaired on the left (paralyzed) leg. This description is taken when the illness was at its worst (page 10).

It shows the most decided interference with the posterior columns in as much as touch was never more interfered with than now. The loss of muscular sense is important because it is a condition that Brown-Squard says with the exception of Sir C. Bell's case (page 31) he never knew to occur in unilateral lesion of the cord (Loccit Vol 11 1868 p. 822).

At the time the notes of this condition were taken I was not aware of the mechanism of muscular sense, and did not so fully examine into its various manifestations at this time that I otherwise should have. Nevertheless the notes are valuable because I did not approach the subject with a biased mind, but simply observed
it in the ordinary course of note taking. The difference between the loss of the muscular sense on the Left and on the Right would have been interesting. That of the Left was of the same nature as it is now, only more intense. It was evidently due more to an error of judgment than to a want of sensation. On the Right side the muscular sense was only absent at the same time as the disappearance of tactile sensibility. It evidently returned with it. At this time also there was apparently pressure exerted on the other half of the cord causing the slight impairment of sensation on the Left leg. From various reasons it is to be inferred that the lesion soon subsided leaving the tracts for delicate touch and muscular sense comparatively unimpaired.

**Electro-muscular sensibility**

In the few cases of unilateral lesion of the cord in which this condition has been observed it has generally been absent in the paralysed muscles. In my case it was absent temporarily on the Left (paralysed) leg. Why this should be so I cannot quite understand. It may be that as the various sensations cross at different height in the cord this sensation had not yet crossed. In a case of hemiplegia presenting features of resemblance to my case recorded by Dr Baylie the electro-muscular sensibility appeared to be diminished on the side presenting sensory disturbances, and slightly increased on the paralysed leg. (Lancet 1865 Vol: II p 117)
Reflex Mechanisms.

Plantar Reflex. The observations on this reflex vary in their results in recorded cases of unilateral lesion of the cord. The condition in Pottard varied from time to time, but his condition in this respect at the last examination was interesting. The manifestation in the connection with this reflex then were as follows:

On tickling the right sole the movements in response were natural, while the sensation of the tickling was diminished. In the left leg, the movements were scarce detectable, while the sensation of tickling was natural. The phenomena in the right leg might be easily explained. The stimulus producing the reflex action in all probability did not cross to the opposite side, but passing forwards became connected (as is supposed to be the manner in these reflex processes) with the multipolar cells of the anterior horn, and so produced the ordinary reflex contraction. The fibers conveying the sensation to the brain crossed over to the left side but on their upward course they were interrupted by the lesion, and a diminished sensation was the result.

Fig. 5. SN sensory nerve. RB reflex branch from SN to(C) multipolar cell, connected with motor nerve (MN). SN' continuation of SN across cord then up posterior column as sensory path (SP) where lesion (L) interferes with it, and a diminished sensation is conveyed to the higher centers.
While the foregoing diagram accounts for the phenomena presented on the right side it fails in accounting for the phenomena on the left side, when there was a normal sensation and a diminished reaction. If the lesion was situated on a level to destroy the reflex branch it would interfere with the transmission of the sensory fibres because at this level both the central grey matter and posterior columns were affected more or less. But the sensation was conveyed unimpaired to the brain.

There is no evidence so far as we have previously stated of the multipolar cells in the anterior horn being affected. It follows then the fault is situated somewhere between the multipolar cells and the point where the reflex branch leaves the sensory nerve fibre.

The explanation of this phenomenon might be found by supposing that the multipolar cells are situated at a higher level than the corresponding anterior posterior root. The reflex branch in its ascension to those cells would have to pass through the area of disease, and its function destroyed. Anatomical evidence would afford some support for such a supposition. The sensory nerve enters the cord horizontally, and almost immediately crosses over. The anterior roots entering the cord traverse the white substance obliquely upwards before joining the cells. (Crichton in Stricker's Human and Comparative Histology New Sydenham Soc: Vol II p 363)

In two other cases of hemiparaplegia have somewhat similar phenomena been observed by Radcliffe, case in Lancet for 1865 Vol I p 357, and in Bazin, case
already quoted. In a case reported by S. Powers when the injury was situated in the upper cervical region, the "reflexes" (presumably plantar) were diminished on the paralyzed side. (Lancet vol. ii p. 729. 1877). The likelihood that the cause of this diminished reflex, contraction, was the same as in all cases contradicts against the suggestion I have made.

Dr. Byron Bramwell has noted a diminution of the reflex in a case of secondary reflexes of the lateral columns (Disease of the Spinal cord p. 214) There is undoubtedly a secondary reflex in my case also. It is evident from these facts that the ordinary plain reflex is not the specific mechanism usually described and represented in the diagram on page 63.

**Lemov Reflex**

Powers in the second edition of The Spinal cord states that it is not of the nature of a spinal reflex action, but rather a muscle reflex action depending upon the spinal cord. The name should therefore be changed and called "myotatic" contraction. The reason for coming to this conclusion is because Warre and others (confirmed by Bramwell) have pointed out that the contraction follows too rapidly upon the stimulus to be of the nature of a spinal reflex act. (p.26).

The condition of this reflex has been observed in few cases of one sided lesion of the cord. Edb found them markedly increased in an extramedullary lesion (Jenneri's Hope XIII p. 651.) In a case published in
the Centrallblatt för Nervenheilkunde, Dr. H. Schulz, where a man had been stabbed in the back and presented evidence of a lumbar lesion of the cord, the paralysed leg exhibited increased tendon reflex. Unfortunately the symptom was not detailed until six months after the injury when secondary degeneration of the lateral columns would probably have supervened.

In Pollard the left (paralysed) leg has exhibited an increase of this reflex from the date of the first examination. Latterly the right also has exhibited an increase though less in degree compared with the left. Both legs exhibit a similarity in the manifestations both in regard to the muscles get to contract and the manner in which they contracted. Presumably therefore the cause would be the same. In the left leg everything points to a degeneration of the lateral columns. In the right leg the symptoms of such degeneration are only represented by the increased tendon reflex. It may be that there is a slight degeneration of the right lateral columns, insufficient in degree to cause the motor paralysis, or rigidity.

There are two peculiarities I would point out in connection with this case. First the patellar reflex could never be got from tapping the knee while that at the ankle could be readily got. It may be that the weakness of the quadriceps muscle was not so great as that of the leg, which we have seen to have been more paralyzed and more rigid. The other peculiarity which is that the tibialis muscle readily contracted from
tapping its tendon or neighboring bones. As this muscle exhibits most typically the paradoxical contraction (produced in certain diseases when the extremities of a muscle are approximated) it has been stated that the tendon reflex never can be set up on it. (Boas' Disease of the Nervous System, Vol. II, p. 226)

**Mechanism of the Genito-Urinary and Rectal Functions.**

The accurate description of interference with these functions in unilateral lesions of the cord has been neglected. It is unfortunate that it should be so because much light in regard to their mechanism might otherwise have been thrown upon the obscurities that still surround these operations. Although the knowledge of the parts played by muscular action is fair, the nervous relations are as yet very indefinite. The fact that there are two reflex or automatic centers situated one on either side of the cord, and having intricate connections with the brain, with the bladder and with one another, complicates the process to such an extent that information regarding their nature can only be gained by observations upon human beings who can afford intelligent assistance. A more perfect knowledge of the functions of the various parts of the spinal cord will be necessary for their thorough understanding. I can scarcely imagine that the symptoms exhibited by Pollard are unique, but I have not found a similar condition elsewhere chronicled.
Among the many descriptions of the process of micturition the following is the best:

"According to Zollinger, the normal process is as follows: the increasing fullness of the bladder produces an increasing irritation of the walls; by this sensory irritation a reflex contraction of the detrusor is occasioned through the agency of a centre in the lumbar medulla; at the same time the impulse to urinate reaches the consciousness, when the evacuation may be prevented by voluntary contraction of the sphincter vesicae, or of the urethral muscles which act as sphincters, until the vesical muscles become fatigued and the impulse to urinate diminishes. The tones of the sphincter may also, perhaps, be increased reflexly by the entrance of the first drops of urine into the urethra. After some time fresh and more powerful contractions of the detrusor occur until at last the sphincter is overpowered or is voluntarily relaxed, when the evacuation takes place; it can be hastened by the action of abdominal straining either voluntarily, or, if the impulse to urinate is very strong, of a reflex sort; and is concluded by a few rhythmic contractions of the urethral muscles." (In: Zollinger's Erg: XIII, 514)

The act of micturition is a mixed voluntary and reflex process, employing:

1. Muscles that are purely voluntary—e.g., the abdominal muscles
2. Reflex as the detrusor vesica
3. Both voluntary and reflex, as the sphincter vesica (or the urethral muscles that act as sphincters.) In the natural process these various kinds of muscles are harmonious
by associated in action. In Pottiard they are associated and present the act of micturition performed as first, a purely voluntary act, and second a purely reflex act.

1st. The voluntary act of micturition.

The patient assumes a position calculated to remove any mechanical obstruction to the egress of the urine, stooping forward and throwing his left leg backwards and outwards. He next voluntarily relaxes the sphincter of the bladder. Training, by the contraction of his abdominal muscles, he compresses the bladder, and the urine is forcibly forced out. If he speaks or changes his position the flow is immediately arrested. He is only conscious of the flow by seeing it. The bladder is only partially emptied.

In regard to this voluntary process little need be said. The voluntary action of the abdominal muscles is evident, seeing that we can utilise them or not as we think proper in the natural process. That it was by their action that the bladder was partially evacuated is clear:—1st because when he talked or otherwise employed them their urinary function ceased; and 2nd because the bladder could only be partially emptied. It is also evident that the sphincter is under voluntary control seeing that by its action we can stop the flow at any time.

On the next page I give a diagram representing the various factors that are probably engaged in this act. This and the following two diagrams are modifications from Brown's diagram of the plan of micturition.

(See Dr. stickle's Journ. Med. Mag. p. 441 1st & 2nd)
2nd The Reflex act of micturition.

The process of Pollard's other method of micturition is as follows,—sitting down and opening out his thighs, he passes his finger into his rectum, which produces an irritation sufficient to set in action the detrusor muscle. At the same time the sphincter is reflexly relaxed, and the urine flows out in a good stream—much more forcibly than in the previous method. If he removes his finger, the stimulation of the detrusor ceases, and the muscle no longer contracts. By again inserting the finger the muscle recontracts until the bladder is empty or until the finger is removed. As in the previous method, he is unaware from the ordinary sensation that he is passing urine.

This reflex process of Pollard is more instructive than the voluntary. It will be remembered that the lesson was supposed to involve the automatic centre for the bladder of one side of the cord (page 30). The centre
on the other side is supposed to be intact. The fact that the detrusor can be got to act proves that part of the centre at all events remains. The conduction of the sensory nerves interfered with as is shown by the diminished stimulus that reaches the brain. This interference prevents also the normal stimulation reaching the centre, in order to produce contraction of the detrusor. In cases of increased irritation of afferent nerves (as by inflammation of the mucous membrane of the bladder, urinary calculi, etc.) there is frequent contraction of the detrusor. The converse is the case here. There is a diminished stimulation of the afferent nerves and, consequently, no reaction. To make up for this an increased irritation by introducing the finger into the rectum suffices to set the detrusor into action.

The same thing might occur if the afferent nerves of one side were interfered with, and therefore not necessitate the localization of the lesion at the automatic centre. But there is evidence of the motor nerves also being affected as shown by the relaxed condition of the sphincter ani. Doubtless the urinary sphincter and it may be the detrusor itself does not act so powerfully as in health, but still both do act, provided that the stimulation is sufficient in amount to arouse them. The retention of the power of contraction in the detrusor notwithstanding the destruction of one centre, is explained by the application of Broadbent's principle, that paralysis of muscles bilaterally associated in action
does not follow upon destruction of one of the bi-
lateral associated nerve centres.

Fig. 1. Diagram of the reflex process of micturition as it occurred in Pollard.

By S.s.m the sensory nerve from the mucous membrane of the bladder the patient was conscious of the desire to urinate. Passing his finger into the rectum R. he stimulated the sensory nerve S., whose branch S. commutated with the motor centres for the detrusor (M.D.) and sphincter (M.S.). These by their respective nerves (M.D. or M.S.) stimulate the detrusor muscle, and relax the sphincter, and the bladder is thus evacuated.

It appears to me, further, that in health not only is there required a stimulus necessary to excite the detrusor to contract, but that the stimulation must be kept up else the contraction will cease. This is well exemplified in the case of Pollard, where the cessation of contraction of the detrusor immediately follows the cessation of the stimulation, i.e., the withdrawal of the finger from the rectum. As the setting in action of the detrusor was impossible, reflexly, because of the diminished stimulation, so the maintenance of the contraction is impossible for the same reason. In health the necessary continual stimulation is undoubtedly supplied by the excitation of the afferent nerves by the urine flowing along the urethra.
Think from the consideration of this case that there is a strong presumption in favor of Galley's view, derived chiefly from experiments on animals, that the detrusor verum acts purely in a reflex manner. Most authorities incline to the view that it acts reflexly but is also like the sphincters under voluntary control. All its actions can be explained withoutrequiring to assume that it is controlled by the will.

I would therefore submit the following modification of Poche's diagram as a probable plan of the natural process of micturition, modifying it in so far as to leave out the connection of the detrusor verum with the brain, and, like Byrom Bramwell, introducing the abdominal muscles.

![Diagram showing probable plan of the mechanism of micturition](image)

**Fig. 8. Diagram showing probable plan of the mechanism of micturition**

- **MT.** motor tract in the spinal cord;
- **M.M.S.** centre of m.s. motor nerve for sphincter;
- **M.D.** centre of d.m. motor nerve for detrusor;
- **S**. arterial nerve from urinary membrane to brain, with s'branch to **M.S.** and 

At the condition during rest is indicated, the sphincter centre is in action, the detrusor centre not acting. At a, the condition during action is indicated, the sphincter centre prohibited, the detrusor centre acting.

(Nile Poche Ovarie, of Spinal Cord p. 144 2nd ed.)
The sexual function is still in abeyance. The reason for this is, that the process is a result of a summation of causes, originating in peripheral irritation and cerebral excitation. One half of these stimuli being removed, the reflex action cannot normally take place as in the primary process. The necessary stimulation being of a peculiar nature it cannot be substituted by another form of irritation as in micturition.

The process of defecation is somewhat analogous to that of micturition. Here also there is called into play:

1st. Muscles acting voluntarily (abdominal and respiratory muscles)
2nd. " " reflexly (Intestinal walls of the rectum)
3rd. " " that act either reflexly or voluntarily (semireticular)

Unlike the urinary process that of defecation cannot be accomplished by employing voluntary muscles alone. For "a body introduced per anum into the empty rectum is not affected by even forcible contraction of the abdominal walls." (Foster's Text Book of Physiology, p. 272)

As in the urinary process extra stimulation has to be provided to excite the effectant nerves that remain intact, in order to excite contraction of the rectum. In the early stage of disease the patient had to pass his finger into the anus and thus succeed to excite contraction of the rectum, and expulsion of the feces.

(page 1) In the last description of this process the patient employs permutaries in order to get a motion (page 23). The reason for this is, that the ordinary motion does not excite sufficient stimulation, but
that the irritant effect of a liquid motion suffice to produce the reflex act. As in the case of the detrusor urinae, the action of the rectum appears to be by a purely reflex process.

Finis.