Remarks

ON

PARALYSIS OF THE MOVEMENTS OF THE TRUNK IN HEMIPLEGIA,

AND THE MUSCLES WHICH ARE AFFECTED.

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THIS paper is intended to show that in some cases of hemiplegia—let us say left—the trunk muscles of *each* side act weakly when they take part in left-sided movements, and the same muscles act normally when they take part in right-sided movements; also that the movements of the trunk requiring bilateral action of muscles are very little, or not at all, affected. The question is discussed of the change in representation of one and the same group of muscles from one hemisphere to the other accordingly as they act in right-sided or left-sided movements; and also the question of the representation of movements requiring bilateral action of muscles in one or both hemispheres.

The condition of the muscles of the trunk in hemiplegia and the question whether the movements in which they take part are paralysed or not has always presented considerable difficulty. In this paper I propose to describe a case of hemiplegia in which certain movements of the trunk were defective, so that, amongst other defects, the patient fell towards the hemiplegic side in trying to sit up; to analyse the muscles which take part in these defective movements; to compare these voluntary movements with those produced by morbid conditions in man, and with those elicited by cortical electric stimulation in animals in reference to representation of the movements in one or both hemispheres; and to describe the methods of ascertaining these defective movements in man.

The patient was under my care at the Great Northern Central Hospital. According to the notes of Mr. Clayton, the house-physician, he was aged 52, married, a confectioner, but twenty years ago was a soldier in India. He had had gonorrhoea, but there was no history of syphilis and no history of alcoholism. He had a fall from a bicycle a week before the onset, which was sudden, without loss of consciousness, and he lost power in the left arm and leg. On admission, there was no facial paralysis, the ocular movements were normal, the tongue when protruded deviated slightly to the *right*, but he had more difficulty in putting the tip against the left cheek than the right. There was complete loss of power in the left upper and lower limbs, and the joints in the left lower limb were rather rigid. Sensation over the whole of the left half of the body and face and the left limbs was diminished to tactile and painful stimuli. The deep reflexes were about equal on the two sides, while the superficial abdominal reflexes were diminished on the left side, and the left plantar reflex gave extension of the big toe when the sole of the foot was stimulated on the outer side, and flexion on the inner side. There was reduplication of the first cardiac sound at the apex of the heart; the blood pressure was 200 to 215 mm. of Hg; urine 1016, no albumen. There was no optic neuritis.

In sixteen days from the time of onset he began to recover movement in the left upper limb, but there was no return in the leg till after another five days. In about twenty-eight days after onset he had recovered all movements of the upper limb, including those of the hand and elbow, and he could advance and abduct the shoulder, but he had no power to elevate the left shoulder girdle. In voluntary coughing the left latissimus dorsi contracted much less than did its fellow on the right, though in adduction of the humerus the left latissimus dorsi acted almost normally.

When put into the sitting position in bed the patient fell over to the left side, and when he had fallen to that side he was unable to raise himself to the vertical position again; but if he was inclined to the right, so that his centre of gravity fell to the right of the spine, he could keep himself in that position. On testing the recti abdominis when lying on his back, by making the patient flex the head and neck, the muscles contracted with equal strength, but the right rectus began to contract before the left; also, on testing the erectores spinae in extending the spine with the patient lying on his face, both muscles contracted equally, but the right moved first. When lying down lateral abduction of the trunk against resistance was noted to be stronger towards the right than to the left.

In another week he had recovered almost normal power in the left limbs with the exception of elevation of the left shoulder; also in forced inspiration elevation of the left shoulder was less than on the right.

On further testing the movements of the head and neck, it was found that in lateral adduction of the neck to one shoulder the trapezius (clavicular fibres), splenius capitis, levator anguli scapulae, and sterno-mastoid of that side took part, but the movement to the right shoulder was stronger than that to the left. In rotation of the head and neck to one side, the rotation to the right, in which the left sterno-mastoid and trapezius act with the right splenius capitis and levator anguli scapulae, was stronger than rotation to the left. Therefore the left sterno-mastoid and trapezius take part in the paretic left-sided movement of adduction of the head and neck to the left shoulder, and the same left-sided muscles take part in the strong, normal right-sided movement of rotating the head and neck to the right side.

About two months after the onset he could sit up without falling to the left, and the strength of the lateral movements of the trunk on the two sides was measured. The patient was seated on a stool and the thighs were fixed by an assistant so as to have a horizontal base line. A jack-towel was passed over the patient's left or right shoulder, and was connected to a traction dynamometer, which was fastened to a fixed point. Starting from the vertical position, lateral traction to the left by the patient gave 13 kilograms and to the right 18 kilograms, and in a second trial 18 and 22 kilograms respectively.

The patient was then inclined to the left with his trunk at an angle of 45° to his base line, and he made traction on the dynamometer towards the vertical line with a force of 13 kilograms, while from the right inclination towards the vertical line the force was 22 kilograms; on a second trial the figures were 12 and 20 kilograms respectively.

The difference between the two sides (4 kilograms) in the first set of observations was not great, but the measurement was made two months after the onset, when the patient had considerably recovered. In the second set the difference was much more (8 to 9 kilograms), and to avoid the error of the difference being due to a left-sided movement, a healthy man was tested, and it was found that the movements on the two sides gave the same strength.

With regard to the pathology of the case, the lesion was probably a syphilitic arteritis, causing thrombosis of the branches from the anterior choroid artery to the posterior limb of the right internal capsule, so that the lower limb was affected more than the upper limb, which recovered first, and the trunk muscles were unusually severely affected; there was also some slight left hemianaesthesia. The movements of the face were unaffected, and this would be due to the fibres near the genu of the internal capsule, which on electric stimulation give movements of the face, being supplied by the posterior communicating artery, which in this case was apparently not involved.

The severe paralysis of some of the left-sided movements of the trunk, the loss of elevation of the shoulder, the slight affection of the hand movements, and the more complete paralysis of the leg as compared with the arm, are exactly the symptoms given by Horsley and Schäfer³ after removal of the right marginal gyrus; and it would seem that the fibres of the internal capsule, which come from the marginal gyrus, must have been especially involved.

The patient was treated with potassium iodide.

The patient recovered all the movements of the limbs and trunk, with the exception of the elevation of the left shoulder, which was still deficient three months after the onset.

In considering this case it is desirable first to ascertain the muscles which take part in the defective movements and are responsible for their proper performance.

The patient fell over to the left side when he was put into the sitting posture in bed. Also when he had fallen over to the left side he was unable to raise himself from this position on his left side to the vertical mid-line.

A patient in the sitting position falls to the left, because the muscles which should counteract the action of gravity are paralysed, for in every unopposed movement in the direction of gravity it is the antagonists which act, and not the muscles which are the prime movers.

In the supine position, when the lateral movements are not influenced by gravity, the prime movers in the movement of the spine from the mid-line to the left are the left erector spinae and rectus abdominis, and the antagonists to this movement are the right erector spinae and rectus abdominis. Therefore when the trunk is in the vertical position, to prevent the spine falling from the mid-line to the left, owing to the action of gravity, the right trunk muscles (by which is meant the erector spinae, the rectus abdominis, and perhaps the oblique externus and internus) should contract, and their inability to do so shows that they are paralysed. In the same way, when the patient has fallen over to the left side, the muscles which should raise the trunk from that position to the vertical mid-line—that is, adduct from the left to the mid-line—are the *right* erector spinae and rectus abdominis, but in this case the patient was unable to perform this movement, owing to paralysis of these muscles for this particular movement. From the above it is seen

that the same muscles—that is, the right trunk muscles—take part in the unopposed movement in the direction of gravity, of abduction from the mid-line to the left, and also in the opposite movement against gravity of adduction from the left to the mid-line. The difference in the action of the muscles is that in the first case the muscles contract and gradually elongate to let the trunk fall to the left, and in the second case the muscles are elongated to start with and in contracting they gradually shorten and draw up the trunk to the vertical position. The simplest example of these two opposite movements is that of the elbow-joint. If the humerus be placed horizontally and the forearm be put vertically upwards at a right angle to the humerus, and if then the person be told to extend the elbow slowly, the triceps starts the movement, but as soon as the vertical position is passed and the forearm is acted on by gravity the triceps ceases acting, and the biceps and other flexors contract to prevent the forearm falling rapidly, and the muscles elongate gradually to their full extent. If then the elbow be flexed against gravity the same muscles, biceps and other flexors of the elbow, will contract and carry the forearm to the vertical position.

It is a question whether these two opposite movements are represented in the same part of the "motor" cortex, or whether the extensor movement is represented in the cortical extensor area of the elbow and the flexor movement in the flexor area; but as in the extensor movement in the direction of gravity the first action of the muscles is that of flexion to neutralize gravity, it seems that though the idea in the person's mind is that he is performing an extension movement, the movement is really being produced by gravity, and the rôle of the "motor" cortex is to cause just so much contraction of the flexors as will prevent gravity acting too quickly. To test this question in the arm it would be necessary to have a case of hemiplegia in which there was recovery of the movement of flexion, and paralysis of the movement of extension of the elbow, and then observe whether the movement of extending the arm in the direction of gravity could be performed slowly. In the case of left hemiplegia here described the inability of the *right* trunk muscles to prevent the trunk falling to the left under the influence of gravity was in marked contrast to the power with which the *left* trunk muscles could bend the trunk against resistance in the same direction. In fact, the weakness in the former movement corresponded to that in the movement of adduction from the left to the mid-line. In other words, when in the early stages the patient fell over to his left side and had not the strength to lift himself up again, he could carry the trunk from the mid-line to the left against resistance with very fair force, although normally the ratio of power of adduction from the left to the mid-line is to that of abduction from the mid-line to the left as 3 to 2, owing to the muscle being elongated and working at a greater advantage in the first case. This would make it probable that unopposed abduction of the trunk towards gravity to the left and adduction from the left to the mid-line against gravity were represented in the same part of the "motor" cortex.

The next question is, Are these movements of letting the trunk incline to the left and of drawing it from the left to the vertical position, which are accomplished by the right trunk muscles, right-sided or left-sided movements? It seems to me that they must be looked upon as left-sided movements, as they take place in the field of movement situated to the left of the middle line of the body, just as unopposed lateral inclination of the spine to the right and drawing of the spine from the right to the mid-line, that is, adduction from the right to the mid-line, must be looked upon as right-sided movements though they are performed by the left trunk muscles, which in this movement acted normally.

The fact that the loss of these two movements in the left field of action occurred in a case of left hemiplegia is strongly in favour of these movements being left-sided, and consequently of their being liable to be paralysed in a lesion of the right hemisphere.

The other movement which was deficient was that of abducting against resistance the spine from the middle line to the left, which was found to be weaker than the movement of abduction to the right. This movement from the mid-line to the left is performed by the left trunk muscles, especially the left rectus abdominis and erector

spinae, while the corresponding normal movement on the right side is performed by the right trunk muscles.

We have, therefore, in this case of left hemiplegia the *right* trunk muscles (1) acting weakly, or not at all, in the unopposed *left-sided* movement of preventing the trunk falling from the mid-line to the left, and in the *left-sided* movement of abducting the spine against resistance from the left to the mid-line, and (2) acting strongly and normally in the *right-sided* movement of abducting the spine from the mid-line to the right against resistance. Conversely we have the *left-sided* trunk muscles (1) acting strongly and normally in the *right-sided* movements of preventing the trunk falling from the mid-line to the right, and in adducting the spine from the right to the mid-line, and (2) acting weakly in the *left-sided* movement of abducting the spine from the mid-line to the left against resistance.

If it should seem anomalous that the right trunk muscles should be paralysed in a left hemiplegia, depending on a lesion of the right hemisphere, for left side movements and not for right, it must be remembered that we have examples in other muscles of a similar condition.

The right sterno-mastoid takes part in the right-sided movement of adduction of the head to the right shoulder as well as in the left-sided movement of rotating the head with the face to the left, and it was found in this case that there was weakness of the left-sided movement of rotation with preservation of the right-sided movement of adduction.

The above apparent anomalies disappear if in dealing with hemiplegia we always remember Hughlings Jackson's dictum, that the brain knows nothing about muscles but only of movements, and all that we have to take into account is, whether the movement takes place in the field of action on the right or the left of the antero-posterior mid-line of the body.

It might be thought that if a person in the sitting position starts from the extreme left lateral position and moves the trunk to the vertical position and thence to the extreme right lateral position against resistance, which might be applied by the hand of the observer acting against the right shoulder, he would perform one movement, as the same muscles—that is, the right trunk muscles—are acting throughout the movement. But from what was found in this case of left hemiplegia this movement cannot be looked upon as one movement. In this case the patient was quite unable to perform the first part of the movement from the extreme left to the mid-line, but he could perform the second part from the mid-line to the extreme right. We must therefore consider the first part as a paralysed left-sided movement and the second half as a normal right-sided movement. If this be correct, then the movement from the extreme left to the mid-line—adduction from the left—must be represented in the right "motor" cortex, and that from the mid-line to the extreme right—abduction to the right—must be represented in the left "motor" cortex.

Therefore if this movement be made continuously from left to right, there must be a change of the representation of the movement from the "motor" cortex of the right hemisphere to that of the left, when the mid-line is passed.

If this be so when the mid-line of the body corresponds to the vertical line, what would happen if the mid-line were inclined 30 degrees to the left of the vertical plumb-line? Will the presumed change of hemisphere take place when the spine reaches the mid-line (in a line with the sacrum) or when it reaches the vertical line—that is, will the whole of the movement from the extreme left to the vertical line be represented in the right hemisphere, or will the part of the movement between the mid-line and the vertical line be represented in the left hemisphere?

The following procedure will put the matter more clearly: A normal person sits on a plane inclined 30 degrees to the horizon, so that the right ischial tuberosity is an inch or two higher than the left, and the pelvis is consequently tilted to the left, and the mid-line of the sacrum and the spine is inclined 30 degrees to 45 degrees to the vertical line. The trunk is then placed in a position inclined laterally as far as possible to the left, and the person raises the trunk against gravity to the vertical position without altering the tilt of the pelvis. The right trunk muscles will then be felt to contract

throughout the movement, and we have to determine whether it is a right or a left sided movement. The movement from the beginning to the point where the spine is in a straight line with the sacrum—that is, the mid-line—must be considered to be a left-sided movement, and to emanate from the right cortex, while from the mid-line to the vertical line the movement must be considered right-sided, and to emanate from the left cortex.

We have, therefore, the same muscles producing an apparently similar movement throughout, but when this movement crosses the mid-line there must be a change of impulses from one hemisphere to the other, and the question arises—how is this change accomplished?

The advantage in the above procedure of tilting the pelvis and putting the mid-line of the trunk at an angle to the vertical line is that in the whole movement to be performed the weight to be raised remains constant—namely, lifting up the weight of the trunk against gravity; whereas, if the pelvis were on a horizontal plane, the first part of the movement, even if made against resistance, would be against gravity, and the second part in the direction of gravity, and this change would give an indication when the mid-line was passed. When the pelvis is tilted no such indication is present, and if the person closes the eyes, the only information which is sent to the cerebrum is that of the afferent impressions from the joints and muscles, and from the semicircular canals.

In every voluntary movement the mechanism is sensorimotor, and it is presumed that the cerebral hemispheres are kept informed by the afferent impressions concerning the relation of the spine to the fixed point of the sacrum and pelvis, and it would thus be determined, according as the movements required are left-sided or right-sided, whether the impulses should come from the right or the left hemisphere—for example, a movement required to carry the spine from the mid-line to the right would be, so to say, registered as a right-sided movement to be put into action by the left "motor" cortex. If this be correct, it would be another instance of how completely muscular movements are under the control and domination of afferent impressions from the muscles and joints, as is seen in locomotor ataxia, and in the important experiments of Sherrington and Mott,¹ who produced complete paralysis of the upper limb in a monkey by dividing all the posterior roots coming from it.

In the case of left hemiplegia here described it is important to note that the paralysis of the movements of the trunk was confined to those which were unilateral—that is, adduction and abduction of the spine—and it was found that in the movements of flexion and extension of the spine no difference in the strength of the rectus abdominis or of the erector spinae of the two sides could be made out; the only difference seen was that the muscles of the right side started the movement sooner than those of the left.

What light does experimental physiology and clinical observation throw on this subject?

From experimental physiology we have the movements which have been obtained in monkeys and in the anthropoid apes from electrical stimulation of the cortex and of the internal capsule. According to Sir Victor Horsley and the writer,² from stimulation of the internal capsule in the monkey no movement was ever seen in both recti or obliqui abdominis, but invariably movement restricted to the muscles of the opposite side, notably the rectus, was seen. From the result of excitation or ablation of the "trunk areas" in the marginal gyrus, Horsley and Schäfer³ considered that the same unilateral representation existed. Also in Grünbaum and Sherrington's⁴ experiments on the anthropoid apes the same unilateral result was obtained.

The movements of flexion or extension of the spine have not been obtained from electrical stimulation of one hemisphere. According to the experiments of Mott and Schäfer,⁵ who stimulated simultaneously the identical motor centres in both hemispheres for the movement of rotation of the head and eyes to the opposite side and upwards or downwards, upward and downward movement of the eyes could be obtained, and also presumably of the head, though no mention is made of the movements of the head from this bilateral stimulation. What holds good with regard to flexion and extension of the head, would probably apply to the movements of flexion and extension

of the spine, and this would postulate that impulses would have to emanate from the centres of both hemispheres to produce a bilateral movement. This might also explain why, in the case of left hemiplegia here described, the contraction of the left rectus abdominis and of the left erector spinae occurred later than on the right side in the movements of flexion and extension of the spine. If these bilateral movements are represented in those cortical centres of both hemispheres which preside over the unilateral abductor movements of the spine, it is necessary to assume that the impulses subserving bilateral movements take a different course in the internal capsule to that followed by impulses subserving unilateral movements; otherwise a lesion of one internal capsule, say the right, would block not only the latter but the former set of impulses, with the result that impulses subserving bilateral movements from the left hemisphere only would succeed in passing, and a bilateral movement would be converted into a right unilateral movement. In the present case, although the unilateral abduction to the left was weaker than to the right, in flexion and extension of the spine there was no difference in strength of the two recti and erectores, but only a delay in time of the left-sided muscles.

On the other hand, there seems no doubt that some bilateral movements are represented in each hemisphere, so that they are produced by stimulation of the centre in each hemisphere alone. An example of this class of movement is bilateral action of the vocal cords which are put into action by stimulation of the cortex of either side.

In favour of both the recti abdominis muscles being represented in each hemisphere so that the movement of flexion of the spine could be brought about through impulses emanating from one hemisphere is the observation made by Dr. S. A. K. Wilson on a case under the care of Sir W. Gowers at the National Hospital, in which both recti abdominis were seen to be convulsed in fits, which were otherwise unilateral. This might be accounted for either by both recti abdominis being represented in each hemisphere, or by the connexion through the corpus callosum between the "centre" for each rectus in each hemisphere being so intimate, that a fit starting in the "centre" of one hemisphere would easily pass to that of the opposite side.

Against the recti abdominis muscles being both represented in one hemisphere is the fact that only the muscle of the opposite side has been caused to contract by electric stimulation of one hemisphere.

The evidence as far as it goes seems to be in favour of both hemispheres being required to produce the action of both muscles, but at present it is not certain.

Taking the movement of the vocal cords at one end of the scale, and of the upward and downward movement of the eyes, or of flexion and extension of the spine at the other end, I would suggest the following explanation why the latter movements may require both hemispheres to produce action of both sets of muscles. The vocal cords have no movement which is independent of each other or is stronger on one side than on the other, the movements are either abduction, adduction, or shortening, and to ensure that they shall never act otherwise than together, the movements of both cords are represented in a centre in each hemisphere, and each hemisphere can act without the other. On the other hand, in upward and downward movement of the eyes there is every gradation through an arc of 90° between vertical upward movement and horizontal movement to one side—say the left—so that in vertical upward movement the centres in both hemispheres would act equally, but as the upward movement takes place more to the left less impulses would come from the left than from the right hemisphere, till finally, when the movements become horizontal the movements would be entirely from the right hemisphere. Also in the spine between flexion in the mid-line and pure abduction to the left against resistance there is every gradation of lateral flexion, and I have found, in performing the movement of flexing the spine against resistance, starting from the mid-position and flexing more and more to the left, that both recti contract, but the right less and less till, when the spine is flexed laterally in a plane which is 45° to the mid-line, the right rectus ceases to contract, and the left erector spinae

begins to act. It is a question, therefore, how much of these lateral movements is represented in both hemispheres; the movement of flexion in a vertical plane of 45° to the left of the middle line, where the right rectus ceases to act, is probably represented only in the right cortex, but it seems probable that the other movements between mid-line flexion and lateral flexion at 45° are represented also in the left cortex in diminishing degrees.

I would therefore suggest that while the bilateral movements of the vocal cords are represented in the motor cortex of each side, and can be made to contract by the impulses from one hemisphere only, the bilateral movements of the head and spine would require impulses from both hemispheres for their performance.

The movements of the tongue appear to be intermediate. For though from the observations of Sir Victor Horsley and the writer⁶ on the monkey, no difference between the actions of the two halves of the tongue in the movement of protrusion straight could be detected from stimulating the cortex of one hemisphere, yet the frequency in hemiplegia with which the tongue deviates to the paralysed side, when the patient tries to protrude it straight, is in favour of the movement being represented in each hemisphere, but with the muscles of the opposite side being more strongly represented than those of the same side, and not equally in each hemisphere, as in the case of the vocal cords; and although the tongue has lateral movements, the protrusion to one side has a different localization to that of protrusion straight, and the action of the two halves of the tongue in protrusion to one side—say, the left—consists of advancing of the right half and retraction of the left and is quite different to protrusion of the tongue straight, and is, perhaps, in a different category to the antero-lateral flexion of the spine to the left against resistance, where both recti abdominis have an action similar to that of flexing the spine straight, but with the left muscle acting stronger. Other bilateral movements which might be cited as imperfectly bilaterally represented are those of closing the eyelids and of elevation of the soft palate. In the paper already quoted,⁶ we found that in both these movements the closure of the opposite eyelids and elevation of the soft palate on the opposite side could be obtained without the movements of the same side by stimulation of one hemisphere; but as occasionally the movements of both sides were obtained from one hemisphere, we must look upon them as not pure causes of unilateral representation, but that the two sides are unequally represented in each hemisphere. An interesting point is that it is not possible to voluntarily elevate one half of the soft palate, and also that many people cannot close one eye without the other.

In reference to other clinical observations, I would refer to a case of double athetosis now under my care in the National Hospital, in which the movements are much more marked on the left side. On the left side there is frequent clonic contraction of the left trunk muscles, and especially of the left rectus abdominis and the left erector spinae; but there is no movement at all of the right rectus abdominis, and only a much less marked movement of the right erector spinae.

These clinical cases show that contractions of the abdominal muscles, limited to one side, can be produced by cerebral disease, and are thus in harmony with the results of electrical stimulation of the cortex of one hemisphere.

With regard to previous observers, Dr. Hughlings Jackson⁷ has expressed the opinion that in cases of hemiplegia—say the left—there is some very slight weakness of the lower part of the erector spinae muscle on the right side, the side of the cerebral lesion.

Of the other points of interest in this case, I might mention the action of the latissimus dorsi as a voluntary muscle and as an expiratory muscle of coughing. I have elsewhere⁸ shown that in hemiplegia, as a rule, the latissimus dorsi will act with its fellow of the other side as a muscle of voluntary forced expiration, when it will not act in the unilateral movement of adducting the humerus. In this case, however, the left latissimus did not contract so well on voluntary coughing as the opposite muscle, even when the left latissimus had recovered its power as an adductor of the left humerus. This case, therefore, differed from the majority of hemiplegias in this action of the latissimus dorsi, as well as in the arm recovering before the leg, in the elevation of the shoulder being the last move-

ment to recover, and also in the extensive degree in which the left lateral movements of the trunk were affected.

Another point of interest related to the question whether individual muscles or movements are represented in the "motor" cortex. The condition met with in this case of left hemiplegia, of the trunk muscles of each side acting strongly in right-sided movements, and weakly or hardly at all in left-sided movements, makes it very difficult, if not impossible, to explain how individual muscles could be represented in the cortex—a theory which has been upheld by some observers.

CONCLUSIONS.

In this case the patient in sitting up fell over to the left, and when over to the left he was unable to adduct the spine to the vertical position, but when in the vertical position he could push to the right more strongly than to the left. The muscle movements required for the prevention of falling to the left, and for adduction of the spine from the left to the mid-line are considered to be left-sided movements, and to be performed by the *right* trunk muscles; and abduction of the spine from the mid-line to the right against resistance is considered to be a right-sided movement, and also to be performed by the *right* trunk muscles. Therefore the right trunk muscles were paralysed or weak when they acted in left-sided movements, and were normal when they acted as right-sided movements. Conversely the left trunk muscles acted normally in right-sided movements (adduction from right to mid-line) and weakly in left-sided movements (abduction against resistance from mid-line to left). The movements of slow unopposed abduction of the spine from mid-line to left (that is, letting the trunk fall to the left), and of adduction of the spine against gravity from the left to the mid-line are probably localized in the same part of the "motor" cortex.

In making the lateral movement of the spine against resistance from the extreme left through the vertical position to the extreme right, the first half of the movement from the extreme left to mid-line is a left-sided movement, and the second half from mid-line to extreme right is a right-sided movement, and on the mid-line the cortical representation must change from the right to the left hemisphere. It is probable that this change is brought about by the afferent impressions from the joints and muscles of the spinal column.

The movements of the spine which were paralysed or acted weakly were unilateral; two sides taking part in the movements of flexing and extending the spine acted equally strongly though the muscles on the hemiplegic side acted later than on the other side.

From the above observation and that the movements of the trunk obtained by stimulation of the cortex or internal capsule are always unilateral, it seems probable either that the muscles of both sides are represented in the "motor" cortex of each hemisphere, or that the muscles of each side are represented in each opposite hemisphere, and that the association between them through the corpus callosum is very close. In bilateral movements generally the first arrangement is probably that of the representation of the vocal cords, and the second that of the flexors and extensors of the spine, while the bilateral movements of the tongue, of the soft palate, and of closing the eyes are intermediate, and muscles of both sides probably are represented in each hemisphere in varying degrees.

The method of testing and the movements which we should direct the patient to make are most important. In cannot be too strongly emphasized that it is not a question of which particular muscle is weak, but, in the first place, which particular movement is deficient or impossible to perform, and, secondly, which muscles take part in, and are paralysed for, this particular movement.

It has been shown in this case of left hemiplegia that the right rectus abdominis and erector spinae were paralysed when they acted as adductors of the trunk from the left to the mid-line, but they contracted normally when they acted as abductors of the trunk against resistance from the mid-line to the right. It would, therefore, be quite misleading to say that the right trunk muscles were paralysed unless we specified the particular movement, in which they took part, which was deficient.

The movements which we must ask the patient to perform must be unilateral, as the bilateral movements,

from reasons already given, are less liable than the unilateral movements to be paralysed in hemiplegia. The unilateral movements consist in abduction from the mid-line to the right and left, adduction from the right and left to the mid-line, and rotation of the spine with the face turned to the right and then to the left. All these movements should be tested with and without resistance, which should be applied by the hand of the observer against the patient's shoulder, and also both in the position of lying down and in that of sitting up in bed when this is possible, and particular notice should be taken in the latter position whether the patient is unable to prevent himself falling to one side.

REFERENCES.

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A Clinical Lecture

ON

TRAUMATIC HEART DISEASE

AND

COMPENSATION FOR "ACCIDENTS."

DELIVERED AT GUY'S HOSPITAL.

BY

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EVERY now and then some great discovery in pathology or in therapeutics leads us to change the point of view from which we regard certain diseases, in respect of either diagnosis or of treatment.

Recently there has been a social development, not a scientific discovery, which has led us to consider the causation of many diseases from a somewhat altered standpoint. I am referring to the tendency that there is now for all sorts of people to be insured against the results of accidents. In consequence of this habit, the possibility of an injury being the cause of any disease is much more before us as a profession now than it ever was before. The growing prevalence of insurance against accidents is probably responsible for what was to me a novel experience. Just before Christmas there were lying in adjacent beds under my care in Addison Ward two patients suffering from heart disease, each of whom attributed the symptoms from which he was suffering to an accident. This exceptional occurrence led me to choose as my subject for lecture to-day traumatic heart disease. And in introducing to your notice the question of traumatic heart disease by relating to you some of the particulars about these two patients, I propose to take the opportunity of offering for your consideration a classification of traumatism of the heart generally, then to draw your attention to some of the difficulties by which the profession which you are about to enter is assailed owing to the spread of insurance against accidents, and finally to ask you to consider some possible means of avoiding some of these difficulties.

I.—TRAUMATISM OF THE HEART.

There are three very different conditions in which injuries to the heart occur. First, there are the conditions in which gross and obvious injuries to the heart result from external violence. A man is cycling with his machine out of control; he meets and collides with a cart; the shaft penetrates his thorax and causes immediately fatal results. Other examples are those in which the buffer of a train breaking the sternum and the ribs leads to the heart being seriously injured by the bony fragments. Bullet wounds and stabs of the heart are also in this section—conditions, perhaps, of more interest, because they may afford an opportunity of surgical treatment if the injuries are not too extensive. Another interesting injury to the heart due to external violence is worthy of your consideration, inasmuch as you

may yourselves be responsible for causing it in attempts to aspirate the pericardium.

The essential feature of this group of cases is the obvious external violence. The patient seldom survives to present symptoms of heart disease.

The second group consists of cases in which there is a disruptive lesion of the heart, which is certainly not due to any external violence. The patients are found dead, and the muscular wall, generally of the left ventricle, is torn across, and the pericardium is full of blood. In such cases, as a rule, you would find obvious disease of the muscle of the heart, fibroid or fatty, which explains its rupture on such slight provocation. Every now and then it will not be quite clear that there is any obvious antecedent disease, although it seems almost certain that a muscle must be diseased before any internal pressure resulting from the ordinary circulation of the blood would cause it to rupture.

These may prove very interesting cases, because questions may arise as to whether the relatives of a person found dead under such circumstances are or are not entitled to receive compensation on the grounds that he has died as the result of an accident. Certain it is that in some of these cases the patient is found dead in bed, which makes it unlikely that a violent strain is necessary to produce such a rupture. At other times this condition has been found in the case of a man who was exerting himself to his utmost immediately before his death.

I come now to the third group, to which, perhaps, the title "traumatic heart disease" is alone properly given. Introducing you to this group, I will mention the few salient features about 4 cases which have come under my observation.

CASE I.

A young tram conductor, several years before admission, had had rheumatic fever, but believed himself since to have been in perfect health. One night two drunken passengers had to be expelled from his car. He struggled severely in throwing them out, and when he got home a little later, feeling rather exhausted by his efforts, he noticed a curious noise in his chest, and, calling his wife's attention to it, she also was perfectly certain that she could hear a loud noise in his chest which she had never heard before. He came the next morning to the hospital, and was found to have an extraordinarily marked musical murmur, diastolic in rhythm, all over the precordium. He was not suffering from any marked cardiac symptoms beyond that. Here was definite aortic regurgitation, apparently produced or increased by violent struggling; and we imagined that in the struggle he had torn or detached one of the semilunar aortic valves, and was consequently suffering from aortic regurgitation, at present thoroughly compensated.

CASE II.

A painter, 50 years of age, who at the age of 20 had syphilis, and a few years later rheumatic fever, believed himself to be in perfect health from that time until a few weeks before admission. When painting something high up, he slipped, fell, saved himself with a great effort as he fell, and immediately had cardiac pain and breathlessness. When admitted to the hospital, we found that he had aortic stenosis—a well-marked systolic thrill all over the right of his sternum—and distinct evidences of cardiac failure. In his case we imagined that his hypertrophied heart, which resulted from his aortic stenosis, and which had done its work extremely well for many years, was suddenly dilated as a result of the violent effort which he put out.

In both those cases you will see there was pretty clear evidence that the patient had already chronic endocarditis, and that the alleged injury was an injury to a diseased organ.

CASE III.

A sea cook, a little over 20 years old, perfectly well as far as he knew, and telling us that he had never had a day's illness in his life before, was on a voyage from London to Hamburg. Lifting a cauldron of soup off the fire, the ship gave a sudden lurch, and, desperately afraid that the soup might upset and scald him, he put out all his effort to prevent this. He saved it, but immediately suffered from a very severe pain in his heart, and extreme condition of syncope; so that he was laid flat on his back, was kept on his back until the boat reached port, was immediately carried to the hospital at Hamburg, and remained there for many weeks, until it was thought safe for him to travel to England, when he came to the out-patient department at Guy's Hospital.

In his case we assumed, quite wrongly, as I shall show you in a moment, that his tremendously violent effort had ruptured a *healthy* aortic valve; and, under this impression, this case was shown at the Clinical Society. Years afterwards I met this case again in the hospital as an in-patient; and he then told me that, after my careful