

the incompleteness of the present communication, and to express the hope that other observers would investigate this lesion, and use their opportunities to make out its true pathological nature.

ART. IV.—*On Certain Forms of Paralysis and their Treatment by Electricity.* No. II. By WALTER G. SMITH, M.B.; Fellow and Censor of the College of Physicians; Assistant Physician to the Adelaide Hospital.

In the spring of last year I read before the Medical Society of the College of Physicians a paper on the electrical treatment of certain forms of paralysis. The cases then detailed fell under the four heads of Facial Palsy, Lead Paralysis, Local Traumatic Paralysis, and Rheumatic Paralysis.

None of these groups will come under review on this occasion, with the exception of traumatic paralysis, a few additional examples of which will be mentioned; and I intend now to refer especially to two very different and serious affections, viz., Paralysis of the Bladder, and Organic Infantile Paralysis.

As in the former examples, so, also, in the cases of traumatic paralysis to be presently alluded to, the paralysis was due to compression or injury of the nerve interfering with its physiological conducting power, and not to any solution of its anatomical continuity.

I. TRAUMATIC PARALYSIS.

CASE I.—In January, 1870, J. Walshe, a tailor, aged 26, applied at the Dispensary, on account of loss of power in the left hand. On December 27th he fell asleep while drunk, and when he awoke he found that the left hand and arm were numb and powerless. He usually sleeps on the left side.

Notwithstanding the use of a stimulating liniment for some days, the arm has remained in much the same condition. There is complete drop-wrist, also partial anæsthesia to touch on the back of the hand and along the first three fingers, and increased sensibility to cold in the paralysed parts.

Faradization was resorted to twice or thrice a week, and in a month he was able to resume work, and soon perfectly regained the use of the arm. The electric excitability was normal, and the anæsthesia was removed after the third sitting.*

* It may be well to state at the outset that when the term Faradization (*i. e.*, the local application of *induced* currents) is made use of, no demarcation is drawn

CASE II.—Mr. W. F., aged 36, was recommended to me by Mr. Clendinnen in May, 1869, and gave the following account:—About eleven days previously he fell asleep, while under the influence of drink, with his head resting on the right arm. On awakening the arm felt “dead and numb,” and since that time the limb is easily chilled, and though stimulating liniments were resorted to the paralysis showed no sign of amendment. The loss of motility only involved the extensors of the wrist and fingers; the power of supination was retained. Induced electricity was at once resorted to, and in less than a month, after but ten sittings, a nearly perfect cure was effected. He was then obliged to leave Dublin, but I heard from him some time after, to the effect that his arm was almost well, and that he had derived great benefit from the continued use of a volta-electric machine.

It is remarkable that during the first week of treatment the current was much more acutely felt, and produced far stronger contractions on the paralysed than on the non-paralysed limb. This is not usual in traumatic paralysis. It was observable, too, that the paralysed muscles did not respond so actively at the first instant of stimulation as in a few minutes after—it seemed as if the contractility of the muscles required a little time to fully manifest itself.

CASE III.—Jane Edwards, aged 56, came to the Dispensary on May 26th, 1869, complaining of weakness in the left fore-arm. Three nights previously she was leaning out of a window on that arm for about half an hour, the right elbow resting in the left palm. At the end of that time she found that she could not extend the hand, and felt tingling and numbness in the thumb, index and middle fingers. Some benefit was perhaps derived from the use of a liniment; but with the employment of Faradization the arm began to mend at once, and in a fortnight she had quite recovered the use of the muscles. During the whole time she was

between the so-called primary and secondary current. Duchenne, in particular, has sought to establish a distinction between them as to their respective actions on muscles and nerves. I have never been able to satisfy myself that there is any real difference, and believe that, if we simply keep in mind the greater intensity of the secondary current, and its consequent higher penetrating power, it is practically immaterial whether a stronger primary or a weaker secondary current is employed. This is but natural, considering the similarity in the mode of production of the two currents. Dr. Russell Reynolds has, I am glad to find, arrived at the same opinion. (*Lancet*, March 5th, 1870.)

under observation the same facts were noticed as in the last case, viz., exaltation of the electric sensibility in the paralysed arm, and increased response to the electric stimulus.

Recovery would, no doubt, have been even much more rapid in these cases if daily Faradization had been possible.

CASE IV.—In civil practice we seldom have an opportunity of seeing the effects of gunshot wounds of nerves, but the case I am about to mention is one of a class of injuries now unhappily too common.

Last November my friend Mr. S. Knaggs sent Mr. W. P., a farmer, to me for electrical treatment. Mr. P., while driving in his gig on the 5th of January, 1869, was fired at in consequence of an agrarian dispute, in which he had become involved. He was struck in the left arm and the left side of the chest, and as the gun was discharged close to him, he would probably have been mortally wounded were it not for the protection which three coats afforded. A considerable amount of blood was lost at the time. The marks of twelve cicatrices of different sizes were visible on the inner and under surface of the left arm, above the elbow-joint, some of them very small, being caused by grains of shot, others larger and more irregular caused by slugs. One grain of shot remained imbedded under the skin, close to the median basilic vein, having travelled from behind forwards, for there was no trace of wound anteriorly. Common sensibility is impaired along the little finger, and ulnar side of ring finger, and he cannot distinguish between a wet and a dry object, nor take cognizance of the nature of any substance he touches. He is acutely sensitive to tickling, and to the sudden impression of a point, which produces a feel like a foot awaking out of "sleep."

Left fore-arm measured 25·5 centim. (10 in.), right 26·5. (10·5 in.). He is a left-handed man. A heated body is not felt so plainly along the track of the left ulnar as along the right ulnar nerve. The muscles of the left wrist are weakened, the ball of the thumb is flattened and flabby, and the fork of the first finger is atrophied—and, indeed, all the interossei are enfeebled. Faradization was as soon as possible adopted. The grain of shot, which lay under the skin close to, and probably touching, the internal cutaneous nerve, was removed. The extraction of the grain of shot gave him great relief, and he was now able to rest his arm on the table with comfort, a position which previously caused pain. The

extensor muscles and interossei responded freely and perfectly to electric stimulation, an omen of speedy recovery; but a moderate current which was acutely felt on the sound arm was not perceived on the left arm at its lower half. In a few days, under the use of Faradization, he felt as "if the life had come back into the arm;" the feeling of cold and the numbness along the ulna disappeared, and in a short time he was perfectly well. The noticeable features in this history are the long-continued impairment of sensibility and loss of power due to the disturbing effect of a small local injury to the nerves, and the rapid cure following the means adopted.

A few other points suggested by these cases and those already published, require a word or two of comment.

It has been mentioned incidentally once or twice, that stimulating liniments, though so generally prescribed, have proved of little or no service. The experience of others will, perhaps, confirm this opinion; if so, the less time that is wasted before the direct stimulation of nerve and muscle is resorted to the better. The liniment, if so desired, can be used from the first along with the electric treatment. The fact of the electric sensibility and excitability being heightened in two cases may be recalled, and it is not easy to offer any satisfactory explanation of this phenomenon. A very remarkable circumstance, and one of physiological interest, is exemplified in many, if not most, cases of traumatic paralysis, and is illustrated in the foregoing instances. It is the want of correspondence between loss of motion and loss of sensation. Anæsthesia seems to be a less frequent sign of partial nerve lesions than loss of motility, and it is certainly less permanent and more amenable to treatment. Now, why should this be so? When a compound nerve is injured, it is very difficult to explain how it so often happens that total motor paralysis is caused, and little or perhaps no sensory paralysis. We cannot, by the most refined chemical or histological analysis, distinguish between a sensory and a motor nerve fibre, and all our present knowledge points to the intimate and inseparable commingling of the two classes of fibres in the same trunk. Yet, an injury to a compound nerve does not, as a rule, equally damage its motor and sensory fibres, for, "practically, it is the motor filaments which suffer most severely, most often, and most extensively."^a No plausible explanation of this has

^a On this, as well as on many other questions of nerve pathology, consult the admirable little work of Drs. W. Mitchell, G. Morehouse, and W. Keen, on *Gunshot Wounds and other Injuries of Nerves*. Philadelphia: Lippincott & Co. 1864.

yet been offered, though Dr. Mitchell and his colleagues (*op. cit.*) throw out an ingenious hypothesis, which attempts, in part, at least, to explain the anomaly. Is it possible that the *sensitive* fibres of adjoining nerves so inter-communicate that, when a nerve is injured or even cut across, the function of sensation may be carried on by the anastomoses between it and the adjacent filaments? The existence of sensibility in the distribution of a nerve some considerable time—thirty months—after as much as two inches of it (the median nerve) had been excised, lends some probability to such a view.

In relation to prognosis, it should be remembered, and this is especially insisted upon by the authors already quoted, that the effects of concussion of a nerve may be as serious as those of direct injury or section of the nerve, and that the remote consequences of a nerve-contusion may be as mischievous to the nutrition of a limb, and as permanent, as those which follow total destruction of the nerve.

II. PARALYSIS OF THE BLADDER.

Paralysis of the bladder is known sometimes to follow on over-distension of that viscus, especially in old people, and is now and then observed as a complication of continued fever. We are also familiar with it, in one of its most hopeless aspects, in conjunction with paralysis of the lower extremities, dependent on disease of the spinal cord.

Paralysis of the bladder, *per se*, is not so commonly met with unconnected with loss of motor or sensory power in other organs, or with centric lesion, but the case I will immediately advert to is an example, and an extreme one, of complete vesical paralysis, attended with perfect anæsthesia of a sharply defined region, and unassociated with any other motor or sensory derangement.

M. P., aged 33, was taken into the Adelaide Hospital by Dr. Richardson, in January, 1869. He is a jeweller by trade, and is sometimes obliged to sit working for fifteen hours in the day. He has had gonorrhea three or four times; the last attack dated nearly a year and a half back. About six months ago he perceived that the perineum and inside of the thighs were numb, and that he had not complete control over the bladder. These symptoms were preceded, for some time, by pains running through the limbs. For the last four months he has been compelled to use a catheter almost every day, and urine often dribbles away as he walks, or

when he coughs. The prostate is not enlarged; there is no irritability of the bladder, and he states that the urine always appeared of a natural character. There is not the least evidence of any paralysis, direct or reflex, of the lower extremities. He has not had intercourse for sixteen months, and his virile power is diminished. Sometimes control over the rectum is lost, and the stools pass involuntarily.

The whole of the perineum, as far back as the tubera ischii, and lower part of sacrum—the scrotum and penis—even the glans—are almost completely anæsthetic to the strongest induced current applied by the wire brush, the most powerful means of testing sensibility. The scrotum can be tightly pinched without causing pain, and he is quite indifferent to the hairs being roughly pulled out. A heated spatula is tolerated without inconvenience on these parts, so hot as to cause instant pain when touched to the thighs. The line of analgesia is strictly symmetrical and abruptly limited, and extends up to the external abdominal rings. Within a space of half an inch the transition from the normal sensibility of the adjacent skin to the insensitive tract, was sudden and unmistakeable. Tactile sensibility is preserved.

The effects of treatment may be briefly summed up.

After five applications of the current there was decided increase of the sensibility, and Dr. Richardson found that whereas at first a No. 13 catheter easily slipped into the bladder, a No. 9 was now grasped by the urethra. In a few days he began to regain power over the bladder, and re-acquired command of the rectum, and by the end of March could feel the passage of the catheter. For some months I lost sight of him, and in September he was in much the same way, but could not completely control the functions of the rectum—flatus, and even some fæces, escaping involuntarily.

He was ordered tincture of ergot and perchloride of iron. The Faradization was resumed, and by the middle of October the upper half of the scrotum had partially regained its sensibility. He was next put on a combination of nux vomica and ergot, and on December 17th was much better; retained the urine more completely, and felt a strong current slightly on the penis, and even on the perineum. The electricity was applied as often as he presented himself, and in the beginning of March he had almost perfect command over the bladder, except that he was obliged to strain a little during micturition.

The mode in which the current was employed was as follows:—

The induced current was transmitted into the bladder by means of a bougie electrode, made for me by my friend Mr. C. Ball, connected with the *negative* pole; and a moistened sponge attached to the positive pole was pressed firmly on the hypogastrium, and occasionally placed at the side of the sacrum. Very little benefit would, I believe, have followed from applying one moist conductor above the symphysis pubis, and the other on the lower part of the spine, as is sometimes recommended. The current was seldom passed through the bladder for longer than ten minutes at a time, and in electrifying this organ the possibility of provoking catarrh of the bladder by too strong a current should not be disregarded.

For the relief of the analgesia the wire-brush was constantly resorted to; and to the prolonged use of this, and of the conducting bougie, the success of the treatment is to be attributed.

The bladder seems to be but slightly sensitive to the passage of even an intense current. In the case of the bladder or other non-striated muscle, it is not necessary that every part of the paralysed muscle should be locally stimulated, for it is one of the peculiarities of smooth muscular fibres, in contradistinction to striped muscular fibre, that the contractions excited in them persist for some time after the cessation of the irritation, and, moreover, spread gradually from the muscular fibres in which they begin to the adjacent fibres. Besides, in the case of smooth fibre, the direct stimulation of the muscle exercises a more powerful influence than mediate excitation through the nerves. The contrary holds good with striated muscles.*

The persistence of the anæsthesia after the paralysis was cured is a noticeable feature, for, as a general rule, the prognosis in anæsthesia is much more favourable, even when resulting from organic disease of the nervous centres, than in motor derangements.

The patient's virile power was also materially improved during the continuance of the treatment.

When it is remembered that in this case the incontinence of urine had lasted six months before he was placed under electric treatment, that he had been for a considerable time under medical attendance, was gradually sinking into a more hopeless condition, and was transferred to me as a forlorn hope, the result of the treatment is, I think, eminently satisfactory. It is true, the Faradization

* See MM. Onimus and Legros. De la Contraction des Muscles de la vie Vegetative. Journ. de l'Anat. et de la Phys. No. 4. 1869.

was prolonged over many months; but in such a case this is not discouraging; and of this there can be no doubt, that the first signs of improvement dated from the time that the electricity was systematically directed to the affected organ.

III. ORGANIC INFANTILE PARALYSIS.

Passing now to the subject of infantile paralysis, I wish particularly to urge the importance of early and persevering treatment in this grave affection, and to indicate the grounds on which a less gloomy view of its prognosis than is often taken may be rationally adopted. Before doing so it should be clearly understood, that by the term "Organic Infantile Paralysis" (Hammond) is meant only that class of cases which occur within the earliest years of life, and which are characterized not only by paralysis of motion, but also by extreme atrophy of the muscles and stunting of the bones, and by a cold and cyanotic state of the affected parts. The malady is often known by the name of *essential paralysis*, and has also been described under the titles of *fatty atrophic paralysis of childhood*, *paralysis during dentition*, &c.

This obscure and not unfrequent disease, though its pathology is not thoroughly made out, and we are ignorant of the precise nature of the morbid process, appears, in all probability, to be a spinal affection, and requires to be carefully distinguished from those forms of paralysis occurring in children as a consequence of cerebral mischief. The advanced atrophy, the depreciation of temperature, and especially the diminution or total abolition of electro-contractility sufficiently discriminate the spinal from the cerebral paralysis.

It is scarcely necessary to remark that it differs in several essential particulars from progressive muscular atrophy, and though, like the latter, the muscles are unequally affected, yet the peculiar dissecting character of Cruveilhier's atrophy is wanting in infantile paralysis.

The muscles, in a large number of cases, undergo fatty degeneration; but Drs. Hammond and Volkmann have shown that this is not invariably the case, even in the most severe instances of the disease, and after the lapse of years. The degree of paralysis does not, therefore, strictly correspond, as Duchenne maintained, with that of fatty change. The bladder and rectum are not implicated. Besides the depression of the nutrition of the paralysed limb, we have to dread, as secondary consequences, changes in the shape and

direction of the articular surfaces, and paralytic contractions, giving rise to clubbed feet and other deformities.

CASE I.—J. Harrison, aged two, with dark eyes and blue sclerotics, was brought to the dispensary in the close of April, 1869, by his mother, for advice as to wasting and loss of power in the left leg below the knee. He has always been a delicate child, and liable to attacks of diarrhœa, and has passed through measles and whooping cough. A year ago he had convulsions while teething, and is at present troubled with ascarides. About three or four months since his mother noticed that the left leg was smaller than its fellow, and from that date up to the present the atrophy has been gradually advancing. When he attempts to stand, which he cannot manage to do without support, he inclines to fall to one side, and the left foot turns down on the outside, and is dragged sideways along the ground. When the leg droops the foot is turned in, and the ankle joint is so mobile that the foot can be shaken about as if it hung from a hinge. The left thigh is one quarter of an inch (0·6 cm.) smaller than the right, and the left calf three-quarters of an inch, (1·8 cm.) and the child often complains of that limb being cold. The paralysed muscles are soft and flabby, and the whole nutrition of the limb is seriously impaired. Tickling the left sole excites no reflex contractions, while these are easily provoked on the right side. On the application of an induced current, electro-contraction was greatly diminished. A battery current from 10 Daniell's cells produced no decided effect. For a month I lost sight of him, and on re-examination not the slightest contraction of either the anterior or posterior tibial muscles could be provoked by the strongest induced current. Hence it was manifestly an unpromising case, but notwithstanding this, the Faradization was persevered in, and in a few days there was decided amendment—the foot did not turn in so much, and the child could walk more firmly. By the beginning of July, *i.e.*, about two months after the electric treatment was commenced he could walk a little without assistance, and the ankle was rendered more tense and fixed by the action of the current, but still no distinct contractions could be remarked.

Again he ceased to attend, but on November 2nd his mother brought him to me to show how well he could walk without aid, although a little lame from the arrest of growth of the bones, and told me that matters had been steadily but slowly improving meanwhile. The muscles were still considerably wasted, and no

contractions could be elicited by a powerful induced current, nor was it acutely felt, yet the circumference of the calf had increased by a quarter of an inch.

On making inquiry this week I learned that the child had unfortunately died of scarlatina last month; but his mother assured me that some time before his illness he could walk perfectly well, and that the affected leg was nearly as large as its fellow.

CASE II.—Martha Hyland, aged three, admitted under Dr. Barton, February 24th, 1869. It appeared that she had been neglected for a considerable time, and, on admission, was a wretched looking child. She had had measles, followed by whooping cough, and after that disease had subsided, weakness of the lower extremities remained. After a month's stay in hospital she could merely draw up her legs in bed, but was quite unable to stand or walk. Partial and irregular recovery is of frequent occurrence in infantile paralysis. Recourse was then had to Faradization, and examination showed that contractility was at a low ebb, especially in the quadriceps extensor, while the electric sensibility seemed greatly impaired, for she made no sign of pain or discomfort during the sitting. This is contrary to the general experience. The contractility of the arms was also enfeebled.

In about three weeks the adductors of the thighs and flexors of the toes responded pretty well, but the quadriceps still remained very sluggish. She was almost able to walk when allowed to lean slightly on any means of support. Voluntary power gradually increased, the current was more acutely felt, and on the 17th of May she left hospital able to walk pretty fairly with assistance, and I heard since that date that she was better.

The first of these cases was an example of the more usual form in which only one limb, and that the lower extremity, is affected, and which has been termed "monoplegia;" while the second illustrates the paraplegic form of the disease. The prognosis as regards the restoration of the palsied muscles cannot be determined with any certainty except by the aid of electric stimulation. By no other means can the precise degree of paralysis, or the extent of the default in nutrition be accurately estimated. Many authors take a most unfavourable view of the prospect of renovation of the atrophied muscles, even as to function. Volkmann goes so far as to state that the treatment of infantile paralysis, so much as any endeavour to cure or improve the actual palsy is concerned, may be

considered hopeless, and that it is very improbable that any means will ever be discovered of restoring the interrupted connexion between the nervous centres and the motor apparatus.*

It may be that the limb never completely recovers from the severe shock that it has undergone, but the cases just related hold out, I think, some better ground for hope; and even one successful case is a sufficient answer to such a sweeping condemnation of the utility of treatment *quoad* the paralysis as that just quoted.

Three cardinal points to be remembered during the prosecution of the treatment are, that the muscles may require to be tested with a very strong current, that voluntary power may return although no evidence of muscular contraction can be elicited by electricity, and that perseverance in the means used, in the face of scant amendment and tardy improvement, is quite essential. Particular stress is to be laid on this latter proviso.

No doubt some cases recover spontaneously with rapidity, such as those described twenty years since by Dr. Henry Kennedy;^b but the experience of all who have undertaken the charge of infantile paralysis teaches us that the treatment must commonly be prolonged for many weeks or months, and that even when years have elapsed all hope is not to be abandoned.

The more completely and extensively electro-contractility is disturbed the worse the prognosis, and if the paralysis has lasted for six months or a year before treatment is commenced, very little, if any, hope can be held out.

It would be too long a question to discuss the relative merits and position of the induced, and of the battery current, in the treatment of this ill-understood disease. Each has its advocates; but in order to meet a number of cases with the greatest amount of success it is needful to have the command of either kind of current; and weighty evidence of the utility, and, indeed, necessity of the direct galvanic current has been adduced by Benedikt, Hammond, and others.

* See an exhaustive Lecture on Infantile Paralysis and Paralytic Contractions by Professor Volkmann. *Lancet*, February 19, March 5 and 19, 1870.

^b Dublin Quarterly Journal, February, 1850.