TREATMENT OF SPASTIC PARALYSIS

BY

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The system I propose to outline was developed more than twenty years ago, during the war in the course of work done on soldiers convalescent from cerebrospinal meningitis. It was developed quite empirically, and the theoretical principles underlying the method have only recently been applied. Since the war only the more severe spastic cases—for example, those suffering from cerebral diplegia or Little's disease—have been treated. Recently, however, the work has extended to less spastic cases, such as post-thrombotic paralyses.

Aetiology

The causes of spastic paralysis are many. They include birth injury; encephalitis following the acute specific fevers, such as diphtheria, typhoid, or poliomyelitis; syphilis; and infantile cerebral haemorrhage. Arrest of growth or failure of development of the cerebral cortex is responsible for most cases. There are, too, other obscure causes. In any event the result is damage to the cerebral cortex of a greater or less degree, and this is manifested by motor, sensory, and psychic disturbances. Many of the patients seem to be idiots. Over 50 per cent. of our series of 200 cases gave this impression because of dribbling of saliva and inability to control the facial muscles and to express themselves, but after treatment only four have had to be rejected as true idiots (c.f. case reports). Many patients who were apparent idiots showed quite normal intelligence after the spastic condition had been cured.

Sensory Effects

In spastic paralysis the extent of the associated sensory disturbance is not generally realized. It manifests itself, however, in various ways. There is loss of appreciation of the relative intensity of different stimuli—for example, fine differences of heat and cold and touch are imperceptible. Appreciation of spatial relationships may be lost, the patient being unable to identify the precise part stimulated (tactile localization) or to discriminate between two points of stimulation (tactile discrimination). Some interference with the interpretation of proprioceptive impulses, especially in the smaller joints, may be noted. The muscle spasm itself upsets the normal proprioceptive impulses from both muscles and joints. Astereognosis may also be present.

The importance of these sensory disturbances must always be borne in mind. All the phenomena of in-coordination are for the most part of sensory origin. It follows that educative therapy must also have a sensory basis. The brain must literally be flooded with a sequence of properly regulated sensory impulses.

Motor Disturbances

There is seldom any loss of the impulse to make a movement, but the muscle spasm and sensory impairment cause gross clumsiness.

The increase in tone may be localized to one group of muscles, but is more usually general. Normal tendon reflexes are exaggerated, and the Babinski and Oppenheimer reflexes and Gordon's reflex and ankle clonus may develop. Receptive areas, stimulation of which gives rise

to spasm of the spastic muscles, are situated at the distal parts of the extremities. Any stimulation of these areas in the course of routine treatment must be avoided.

The muscles of the spinal or decerebrate animal, and usually all spastic muscles, respond to a stretch with an increase in tone. This so-called stretch reflex, due to the presence of stretch receptors in the muscle and lying parallel with the muscle fibres, is especially marked in the physiological extensor group of muscles. Because of this reflex response any attempt to move a joint when the muscle tonus is still increased results necessarily in a further increase in the muscle spasm. This must be avoided; the muscle groups should first be inhibited (*vide infra*) before any movements involving stretching are undertaken.

Ataxia in this condition is due to both sensory and motor involvement; it is often marked and of a cerebellar type. There is also decomposition of movement, any action being carried out as if by numbers; thus in trying to bring the heel on to the opposite knee while lying in bed the heel is dragged along until it reaches the knee, raised to the proper height, adducted, and finally placed on the knee. Asynergia is due to the lack of co-ordination between antagonists and agonists. If the patient attempts to flex the elbow the triceps which antagonizes the movement may go into tonic contraction. Dysmetria is shown in that the force employed in any action is ill adapted to the aim of the movement; the hand usually shoots past an object which is to be picked up. Occasionally the spastic paralysis may be associated with some flaccid paralysis, usually of the neck muscles (Fulton, *Arch. Neurol. Psychiat.*, 1934, **31**, 211).

Treatment resolves itself into inhibition of the motor spasm, and intensive sensory, and to a less extent motor, education. The motor education must follow the sensory. The patient may be likened to a baby. There is as yet no appreciable sensory development of the cortex, and so a sensory education together with the inhibition of spasm must precede motor re-education. The simplest actions are taught first and accessory movements added until the finer and more complex muscular efforts are mastered. All the harmful phenomena of the disease are progressive. The exaggerated muscle tone increases, leading finally to contractures and deformities of joints. Sensation becomes more and more impaired, and psychological changes follow in a vicious circle. Thus it is of extreme importance that the patient should begin treatment early.

General Treatment

The general health is supervised and adequate food and rest provided. The patients are told to rest from 2 p.m. to 4 p.m. and to get plenty of sleep at night. If of school age they do not attend school, but are given lessons at home by the mother or else take a correspondence course. School is forbidden because the spasticity is likely to increase in front of others: the awkwardness of their movements often excites jeers from other school mates; they become nervous, their awkwardness increases, and they suffer psychologically. A further point is that the children are often backward and do not get the same benefit from teaching as the normal members of the class. They progress better with individual tuition. The time taken for treatment in the clinics varies from half an hour to an hour each day, depending on the severity of the case.

It should be noted at this point that we do not advise certain forms of therapy for the following reasons: electrotherapy, since it causes muscular contraction and

heightened tone; massage, because it increases the tone of spastic muscles, especially if applied to the receptive areas; and also passive and active movements of the joints of the extremities, for by stimulating the stretch reflex they too cause heightened tone of the muscles. Splinting and bracing is also avoided as much as possible. It is harmful in the extensor group of muscles and the more distal muscle groups, but at times may be used advantageously in inhibiting spasm of a proximal group of muscles, usually flexors—for example, the hamstrings. In these proximal flexor groups the lengthening reaction is elicited and is not harmful. Hydrotherapy is valuable, but the cold douche must be avoided, since it increases tone.

Inhibition of Muscular Spasm

The first essential of treatment is to inhibit the muscular spasm. A warm bath at a temperature of 37° C. is given at the start of treatment. This is a necessary preliminary in any form of education of spastic muscles, and it produces marked relaxation of the spastic muscles. The patient is asked to relax and breathe deeply. At the same time the affected muscles are gently manipulated. This stimulus is a powerful inhibitor of muscle tone. It is important to remember that the most proximal muscle groups of a limb which is in spasm (the deltoid and pectoralis major muscles, etc., in the upper extremity) must be inhibited first; thus the receptive fields are avoided. The muscle groups are treated proximodistally in succession until they relax, the manipulation being as gentle as possible, especially when the distal receptive fields are approached.

These gentle stimuli cause a state of inhibition of the spasm and what is called the inhibitory after-period develops. This period is gradually extended as treatment proceeds, and generally becomes permanent—that is, conditioned. During this inhibitory phase the muscles may be stretched without evoking the stretch reflexes. The attendant then passively moves the joints, starting very gently with the most proximal joint. At the first sign of return of tone the muscle is again inhibited and the joint again put through a complete range of movement. These movements must be very slow and the patient's attention should be concentrated on them, the attendant saying, "I am abducting the shoulder," or, "I am adducting the shoulder." By this "attention training" the proprioceptive sensations are reinforced and sensory re-education takes place. "The patient's mind must be made to follow the movements of the joints and be educated by these movements. . . . The extremities educate the brain." New nerve pathways are opened up and proprioceptive sensation will slowly return. It is essential, however, that with each passive movement the attendant secures the absolute mental co-operation of the patient.

This routine is slow. Advanced cases may need many weeks of inhibition of the more proximal muscles before the distal groups can be treated and the smaller joints moved without exciting the stretch reflex response. However, in time this can be done, and then sensory education of the more distal joints may be undertaken. Until sensory education is complete nothing but the simplest active movements are permitted. The patient and the parents are taught these principles, and may apply them at all times at home, fatigue only being avoided.

As in Pavlov's experiments, we find that inhibition will readily spread. In patients with dribbling of saliva and incontinence of urine and faeces, if the muscles of the face and neck are inhibited and dribbling ceases it is found that often the bladder and rectum will also be controlled.

It is always easier to inhibit successive groups of muscles. Speech returns to some degree without any special training. With continued inhibition and sensory training the muscles develop a state of conditioned inhibition and the spasm disappears. This training may take many years, but during the whole of this time special movements are taught. The first acts taught are those essential to washing, feeding, and dressing. Later on the finer movements such as writing and playing the piano may be acquired.

Special Exercises

Quite apart from the ordinary relaxation exercises, in which the patient is asked to relax or to take a deep breath and relax, deep breathing and sighing exercises are helpful. In another exercise the muscles of the limb are loosely hunched up and released, starting at the shoulder girdle and proceeding down to the fingers. If when the fingers are being moved the muscles of the forearm become spastic the patient is told to relax and the dorsum of the hand is percussed lightly with the attendant's fingers.

The lack of balance, very noticeable in this condition, is to some degree overcome if the attendant can induce the patient to recognize contact between the sole of the foot and the substance of the ground or floor. For this reason in all walking exercises coir matting is used, so that the proprioceptive stimuli will be reinforced by increased cutaneous impulses. Stability is obtained by teaching the patients to climb steps. The weight of the body is forced on to each foot alternately with the patients concentrating all their attention on each movement. Long perseverance in this step-climbing will eventually result in the linking up of the physical balance and mental control. Specially constructed steps covered with coir matting allow the attendant to supervise every movement and give the patient greater confidence. A sand trough is used later, and the greater effort required to keep the balance in the sand further reinforces the sensory impulses and slowly greater control is developed. It is essential to train the patient to get the heel down on the ground, and this is done by the attendant holding each heel. The patient is taught also to stand firmly on both feet and to bend and straighten the legs. The individual control of movements of both the ball and heel of the foot must be taught, and such teaching is accelerated by these methods of proprioceptive reinforcement.

Exercises in Co-ordination

The patient, lying down, is asked to place the heel of one foot on the opposite knee, guided by the assistant if necessary. The movement must be slow and purposive, but the patient must remain relaxed. The child is directed to place his foot in the assistant's hand, which is moved to and from various positions until practically every muscle in the lower extremity has been brought into play. Similar controlled movements are practised with the upper limb. No rhythmic movements or quick cyclic movements are ever attempted.

Often a patient has the appearance of idiocy because the muscles which control the action of swallowing are spastic. Saliva continually dribbles from the mouth, and speech is defective or absent. Early education of these muscles is imperative. Inhibition of spasm is effected, and a fluid pleasant to the palate of the patient must be given at regular intervals in very small doses; sweetened fruit drinks are particularly useful. An effort is made to swallow. Every case has responded to this method. Incontinence of urine and faeces tend to clear up at the same time, due to the spread of conditioned inhibition.

The muscles controlling the movements of the tongue must also be subjected to special exercises. The patient is trained to protrude the tongue, and also to curve it upwards towards the nose and downwards towards the chin. The movement towards the nose is the hardest to perform. All the sounds in which the letters "t," "d," "n," and "w" are involved are the most difficult to utter, and should be concentrated upon. The patient is also asked to point the tongue to either side of the mouth. The child is not asked to put all his mental effort into the movement but is encouraged to relax: the movements are assisted by the attendant, and are attempted only after relaxation of muscle tone has been attained.

A spasm of the muscles of the neck sometimes interferes with the mobility of the lower jaw. It may be noticed that upon waking speech is quite good before full consciousness is established, but immediately consciousness is restored the power of speech is lost. To combat this it is necessary to bring the overcharged muscles to a normal degree of tonicity by tongue exercises. Facilitation is assisted by the continued slow repetition of verses of poetry.

In the finer movements of the small joints of the hand there is often some loss of power. After relaxation of the proximal muscles has been obtained the patient is encouraged to concentrate on mastering these finer movements. When the child first starts to write his hand should be guided by the attendant. Exercises in which the child has become proficient are not repeated each day; attention is centred on the actions he cannot perform. At intervals of two weeks, however, the full routine of exercises is carried through.

Long hours of sleep are necessary, and the child should never be disturbed from his rest, because during sleep there is inhibition of the spasm. This is in accord with Pavlov's theory of sleep. Sometimes there is sleeplessness due to painful spasm. The child may make while sleeping an involuntary movement, which becomes immediately a painful spasm which awakens him. The parents must be trained gently to manipulate such spasms, so that the patient sinks back into a quiet sleep.

Treatment of Fixed Deformities

Most fixed deformities will yield to stretching by special apparatus. Inhibition of spasm must be effected first, and the time of stretching must not exceed half an hour each day and should never cause pain. Some few cases of fixed deformity may need tenotomy (only three in our series of 370 patients). No patient under treatment has ever developed deformity. It is therefore essential to place patients under treatment early. The first manifestations of disease occur at 8 months of age, and the first sign is difficulty in abducting the legs. Treatment should be begun at this early age if possible.

Special surgical boots may have to be worn to combat inversion and eversion deformities of the feet. The toe-caps of the boots are removed to allow free movement of the smaller joints, and to stop spasm consequent on compression of the distal receptive areas. Only the heel of the boot should be fully built up, otherwise there will be some interference with the freedom of toe movement.

Other Forms of Treatment

Ramisetomy has now no part in the treatment of spastic paralysis. There is no sympathetic nervous supply to skeletal muscle other than that to the blood vessels in the muscles (Hinsey, *Physiol. Rev.*, 1934, **14**, 562). In

our experience ramisetomy is often harmful, the preliminary flaccidity of the muscles lasting only for a short period. Later the muscles regain their spasticity, and by this time the general condition has often deteriorated. Retention or other disturbances of micturition may follow.

Stoffel's operation of partial section of the motor nerves to a group of muscles, which has been applied especially to the obturator nerve, results at first in a dramatic reduction in muscle tone. Later on, however, the paralysed part of the muscle becomes fibrosed and retracts, spasticity returns, and the proprioceptive muscle sensation is grossly altered. The muscles are even more inco-ordinate and spastic than before.

The usual re-education by massage and remedial exercises seems to us inadequate. It is only the extreme attention to detail and incessant application that leads to results such as have been obtained in the Kenny clinics. The ideals of treatment of each form of educational therapy are the same—that is, relaxation of the spasm and co-ordinative exercises—but it is in the fulfilling of this desire and in the strict application of detail that the usual routine breaks down. Several clinics, notably in America and England, are striving after the ideal, but they do not go quite far enough and their methods are not sufficiently intensive. For example, one method advocates the training of co-ordination by swimming exercises in a warm pool. The warmth inhibits the spasm, and the water takes the weight off the limb and the stretch reflex is not evoked so easily. This is quite true, but the swimming is an active form of motor education. The effort of movement causes an increase in the central excitatory state and the muscles regain their hyper-tonicity. Education of the spastic child must start at the simplest actions and gradually progress, just as does a baby. Rhythmic exercises and cycling exercises also start at too advanced a stage, and so defeat their object. A spastic patient may be taught in a short time to ride a bicycle and yet be totally inco-ordinate in using the lower limbs. Of course a degree of progress is made and good work is being done in these few interested clinics, but elsewhere these patients are often looked upon as hopeless cases.

Illustrative Case Reports

Case 1.—A child, aged 8, of Townsville, Queensland, had had spastic paralysis from birth; labour was prolonged, and the infant very cyanosed. Had orthodox remedial therapy treatment from the age of 1 until the age of 8. On examination in March, 1933, he could not stand up alone, walked on the toes with his feet wide apart, and continuously fell. He was unable to get up after falling. There was incontinence of urine and faeces, and saliva dribbled from the mouth. His speech was explosive, and he could not feed, wash, nor dress himself. He appeared to be subnormal mentally. Contractions of the tendo Achilles and muscles of shoulder girdle were noted, and there was flaccidity of wrists and hands.

By November, 1934, the child was almost normal. He could walk normally, even when blindfolded. Incontinence of urine and faeces was no longer present, and there was no dribbling saliva. He could wash, dress, and clothe himself, and could use a pencil in writing and speak normally.

Case 2.—A youth, aged 18, of Townsville, Queensland, was spastic from birth. On examination in July, 1935, both arms and legs were found to be affected. He could walk, but only with the typical difficult scissors gait. When he sat on a chair there was a spasm of the hamstring muscles, the lower legs would coil underneath the seat, and he would fall forward on his face. He could feed and dress himself only with great difficulty, and saliva dribbled from his mouth.

On re-examination in January, 1937, after eighteen months' treatment, he could walk normally and control his facial

muscles. He could do general work and even fine work with his hands. He now earns his livelihood assembling wireless sets.

Case 3.—A girl, aged 7, of Sydney, New South Wales, whose spasticity was noticed at the age of 4 months, was flaccid until a movement was attempted, and then there was a tremendous explosion of incoordinate muscular energy. Her hands would be retracted to the back of her neck. Oculogyral spasm was present, dribbling of saliva, and incontinence of urine and faeces. She was thought mentally subnormal, but had treatment from the age of 4 months up to 7 years, when she was given up and regarded as hopeless. She was then treated privately for the following three years, during which time she learnt to read and write, and to sing and play the piano, and could walk with the aid of a stick. Treatment then ceased for ten years. Has had six months' further treatment in 1936, subsequent to the opening of a clinic in Brisbane, and can now walk without the use of a stick.

Case 4.—A child, aged 4, of Brisbane, had paralysis of a mixed flaccid and spastic type from birth. There was marked spasticity of the legs, but flaccidity of neck and arms. This patient was unable to lift his head from his chest, had incontinence of urine and dribbling of saliva, and could not speak. Though pronounced an idiot, he was admitted to the Brisbane clinic in June, 1935.

On re-examination in January, 1937, he could hold his head up normally, and was beginning to speak and feed himself. Fixed contractions of the hamstrings were being reduced gradually. The incontinence of urine and dribbling of saliva had stopped, and intelligence was quite good. Treatment has been continued.

Case 5.—A patient from Townsville had marked astereognosis associated with spasticity. In 1934 the patient had sustained severe head injury, for which decompression was performed. A flaccid paralysis of the right leg cleared up, leaving spastic paralysis of the right face and arm associated with extreme astereognosis. He could not discriminate between a golf ball and a small nut placed in the hand. He had standard remedial therapy for one year without any improvement, but recovered completely after clinic treatment for twelve months.

Case 6.—A child, aged 18 months, had been spastic from birth; the prognosis was regarded as hopeless, and spastic contractions of the arms and legs were already developing in spite of treatment. Dribbling of saliva was present. Babinski responses were present with ankle clonus on both sides. Treatment for twelve months resulted in marked improvement. The reflexes are now normal, there is no dribbling of saliva, and the patient is much brighter mentally. We believe that this child will be normal by the age of 7.

Results of Treatment

The patients we have dealt with on the lines indicated above have been the very worst spastic cases. Even the very worst patients, who on examination appeared to be idiots with marked spastic contractures, have sometimes proved to be of quite normal intelligence and capable of the finest co-ordinative movements such as those involved in dancing and piano playing. Two hundred cases have been treated. Many of them are the rejects from all over the world, and at the beginning of the work only those cases that were pronounced hopeless by a medical committee were treated. No published results we know of can compare with those achieved in Australia.

The treatment requires, above all, energy, enthusiasm, and the maintenance of a cheerful outlook. These factors are best achieved where trained persons are working together, competition and similarity of ideas sustaining the mutual interest. It is found in the clinics that two years' training in both flaccid and spastic types of paralysis is essential before real proficiency is attained. At the end of this time the trainees are examined, and if successful are granted the clinic diploma.

The notes on special exercises have been taken from Elizabeth Kenny's *Infantile Paralysis and Cerebral Diplegia* (1937, Sydney).

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Clinical Memoranda

Ileo-caecal Volvulus in a Mental Patient

It is well known that anomalies in the later stages of intestinal development give rise to conditions in the right side of the abdomen which may lead in later life to a variety of morbid consequences (Waugh, 1920). According to Dott (1923), normal fixation and downward elongation of the ascending colon occurs during the third stage of rotation of the gut, at or about the twelfth week of intra-uterine life. In a proportion of cases, however, deficient fixation and excessive downward elongation of the caecum and ascending colon takes place at this stage of development, giving rise to a mobile colon so that the caecum may occupy one of many abnormal situations. The case reported is an instance of acute obstruction developing as the result of an unduly mobile caecum (Marnoch, 1913-14).

CASE RECORD

The patient was a single woman, aged 40, of poor physique and nutrition, and with a history of pulmonary tuberculosis since adolescence, who was admitted to the Murray Royal Mental Hospital on April 19, 1936, in a state of acute agitated depression.

In December, 1936, as a result of refusal of food, she began to lose weight rapidly, and had to be tube-fed twice daily. On January 21, 1937, during the epidemic, she developed influenza, with a subsequent lighting up of the old tuberculous pulmonary lesion, and from then until the date of her death she ran a remittent pyrexia. During this period she became markedly emaciated.

At 6.30 a.m. on February 16, on returning to bed from stool, she complained of severe pain in the lower abdomen. On examination the abdomen was tender and tense, and there was a large tympanitic swelling occupying the right iliac fossa and hypogastrium, and extending almost to the umbilicus. The patient was restless and obviously in great pain. She collapsed and died at 11.55 a.m. Although a tentative diagnosis of acute intestinal obstruction was made, it was considered that operative intervention was not justified on account of the patient's extreme weakness and acute phthisis.

Post-mortem Findings.—On opening the abdomen the grossly distended caecum, dark purple in colour but still lustrous, filled the lower right portion and extended well over to the left side. The volvulus was reduced with great difficulty, and it was then found that the lowest four feet of ileum had passed anterior to the displaced caecum and become incarcerated in the pelvis. This portion of small intestine was, like the caecum, intensely congested and gangrenous. The mesentery of the lower ileum was continued on to the caecum and ascending colon. There were several old tuberculous scars in the lower ileum, one of which, one inch proximal to the affected bowel, formed an annular cicatrix which considerably narrowed the lumen. The large intestine distal to the volvulus was collapsed, and there was a notable absence of intra-abdominal fat. Both lungs were extensively affected by tuberculosis, but the other viscera showed no evidence of disease.

It is probable that the events leading to the condition occurred in the following sequence. Mobilization of the