MUSCLE GROUP ISOLATION AND NERVE ANASTOMOSIS IN THE TREATMENT OF THE PARALYSES OF THE EXTREMITIES

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V.

MUSCLE GROUP ISOLATION AND NERVE ANASTOMOSIS IN THE TREATMENT OF THE PARALYSES OF THE EXTREMITIES.*

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In a paper read before the American Neurological Association in 1909, with the title "The Surgical Treatment of Athetosis and Spasticities by Muscle Group Isolation", we made a preliminary report of our experience with what we conceived to be a novel method of approaching the problems presented by cases of spastic palsies and athetoses in children. The material upon which this paper was based consisted of four cases, one was a cerebral hemiplegia with athetoid movements in the forearm and fingers, the other three were cerebral diplegias, usually called Little's disease. This method was designated "Muscle Group Isolation," a term descriptive of a procedure which had for its aim an isolation of a single group, or several groups of spastic muscles, by a surgical attack upon the nerve or nerves directly involved. As our material has grown and our experience increased, the utility of this procedure has extended so that it has included in its application the flaccid paralyses.

At this point it seems of advantage for the purpose of making what is to be said clearer, to set down briefly the fundamental principles upon which muscle group isolation is based. Athetoses and spastic conditions of organic origin are similar processes. Athetoid movements may be regarded as variants of permanent tonic spasticities. They may be said to be due to several factors, the most salient of which is a constantly active set of highly irrita-

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tive impulses arising from the cortical motor cells. These impinge upon the muscles which are usually in a condition of slight hypertonus. The overaction of the congenitally stronger muscle group as compared to the weaker antagonistic group causes this temporary state to become permanent, and there results then a characteristic attitude and deformity. The essential mechanism must be thought of as central in origin, meaning that the nerve or nerves supplying the muscle group or groups, which is the conducting mechanism and by which this state is produced, are the anatomical structures which demand primary attention as the focus of operative measures.

As we have advanced in the study of these and allied problems, we have come to believe that definite advance follows a mutual appreciation of surgical and neurological points of view. The neurologist is apt to be concerned with matters pertaining to disturbance of function; the surgeon, on the other hand, with postures typifying end-results and expressed in terms of deformity. There is needed, therefore, a clinical nomenclature which not only covers the origin and end-results, but also the intermediate ground. This includes the more fertile field for therapeutic effort. To accomplish this it is only necessary to express in terms easily understood the nervous and muscular mechanism through which the clinical picture is produced. For example, in describing the adduction of the thighs seen in cerebral diplegias, we have made use of the muscle group involved as well as the nervous agency, thinking of it simply in terms of adductor overaction through the obturator nerve. In like manner in paralytic flexion of the knee, we have called it hamstring overaction through the branches of the sciatic. We regard the various paralytic attitudes of the foot in terms of overacting muscles through their nerve supplies.

We have thought it best to divide our clinical experience tentatively into three groups; each of the groups presents a different phase of the therapeutic problem and has for its solution a different application of the method.

Group I. Athetoses and spasticities.
Treated by muscle group isolation only.

Group II. Flaccid paralyses.
Treated by muscle group isolation and nerve anastomosis.
Group III. Complicated tic movements.
Treated by induced paralysis.

In the first group we have a total of nine cases operated upon.

1. Cerebral hemiplegia with athetosis.
2. Cerebral diplegia. Little's disease.
3. Cerebral diplegia. Little's disease.
4. Cerebral quadriplegia.
5. Cerebral diplegia. Little's disease.
6. Cerebral quadriplegia.
7. Spastic hemiplegia, with slight congenital hydrocephalus.
8. Cerebral diplegia. Little's disease.
9. Cerebral diplegia. Little's disease.

Group I.

In our preliminary report a description of the methods that have been used in treating this class of cases was given, together with a summary of the recent literature. From these sources and our own experience we gave the causes for the lack of permanent results following tenotomy, myotomy, tendon and muscle transplantation as follows:

These methods, besides being merely an attack upon the end-result, have the additional disadvantage of being but transitory in their benefits, the condition being all too frequently reestablished. This is due to the fact that the nerve supply, which is the conducting structure by which the abnormal impulses are brought into action, remains untouched. Furthermore, by the necessary supplementary treatment, *i.e.*, plaster-of-Paris bandages or fixation apparatus, not only are the local antagonists made much weaker, but also the whole muscular mechanism of the extremity is seriously impaired by the confinement in bed and the tight bandaging necessary. This criticism holds true for muscle transplantation in spastic cases; in addition, the scope of this method

is necessarily limited to a narrowly selected group of cases in which only a single muscle may be utilized. Since working on these problems, two other methods designed for the surgical relief of these cases have been reported: 1. Intraperineural neurotomy, by Dr. John Joseph Nutt.* The principles upon which this operation is based appear to us to be unconvincing from the point of view of the physiology of the nervous mechanism which is involved. From a practical point of view there is an evident objection: First, in the actual carrying out of the operation, and second, in the effect of the operation. It would be impossible to perform this operation upon the smaller peripheral nerves; and, furthermore, the operation ought to be more directly applied to the mechanics of muscle groups which are directly concerned in the production of the paralyses. 2. The other procedure, based upon an entirely different conception of the whole problem, has been reported by Foerster and Tietze.† This method consists of resection of the posterior spinal nerve roots. Our objection to this method is based upon the following facts: The magnitude and seriousness of the operation, especially in cases of spastic children, is a positive objection to it. Furthermore, the operation is based on incorrect physiologic principles for these reasons: Motor nerves contain sensory fibres which have nothing particularly to do with the posterior roots, so that cortical rest, whatever that might be, could not possibly result from mere posterior root sections. The overlaping is so considerable that in order to affect a whole spastic extremity, a large number of roots would necessarily have to be cut. This would make the operation one of inadvisable magnitude in the majority of cases. Furthermore, no matter how many roots were cut, no complete sensory paralysis could possibly result. Admitting even that complete sensory paralysis could result, then the very object of an operation of this kind would be done away with, namely, the possibilities of coordinated voluntary movement. It is a well-known fact that in absolutely anesthetic areas no properly coordinated movement can ever be possible.

* The AMERICAN JOURNAL OF ORTHOPEDIC SURGERY, VII, 2, Nov., 1909.
† *Zeit. f. Ortho. Chir.*, October, 22, 1908.

The chief object of treatment in all cases of spasticity is to enable the patient to make properly coordinated movements, with the mechanical disability caused by spasticity rendered as ineffective as possible. The spasticity as such is scarcely the main object of treatment, for the reason that its origin, nature, and localization are still matters of great obscurity. To assign it to the cortex of the brain is neither justified by facts nor upheld by any well-known theories.

Operative Procedures.

Four operations have been performed on spasticities.

The first of these consists of isolating and injecting with alcohol the obturator nerve at its exit from the pelvis. This nerve supplies the gracilis, the adductor brevis, the adductor longus and sometimes also (partly) the pectineus, the hip-joint capsule, the adductor minimus and the main portion of the adductor magnus. It arises from the second, third, and fourth lumbar nerves, and is the only nerve of the plexus that emerges at the medial border of the psoas, behind the common iliac vessels. It runs forward and downward to the obturator canal. It traverses this canal, giving off muscular branches to the obturator muscles, and immediately after making its exit it divides into two branches: an anterior, or stronger, which supplies the adductor longus and brevis, and a posterior, or weaker, which supplies the hip-joint capsule and adductor magnus. The nerve is principally a motor nerve though it contains some sensory fibers.

Operative Technic.

An incision two inches long on anterior aspect of thigh, running vertically, beginning at Poupart's ligament, one-half inch inside its middle point, carried downward through subcutaneous fat to fascia covering the adductor group of muscles. Fascia divided by dissection and the internal border of the adductor brevis and longus made out. Opening carried down to pectineus fascia at horizontal ramus of the pubis; this is divided in line of incision and retracted. The obturator nerve is discovered issuing from

below the horizontal ramus of the pubis at the upper extremity of the wound; it divides at this point into two terminal branches. Above this division the trunk of the nerve is seized with blunt dissecting forceps and drawn upward into the wound. At this point it is injected with an alcoholic solution.

The second operation is planned for the relief of overaction and spasticity in the hamstring groups. Here, the nerves to be attacked are the branches of the great sciatic which supply the hamstring muscles; *i.e.*, the biceps, semimembranosus and the semitendinosus. These branches are given off of the trunk of the great sciatic in the upper half of the thigh.

Operative Technic.

Vertical incision four inches long over the course of the great sciatic nerve; nerve exposed and branches isolated, their identity being determined by the use of a sterilizable electrode and faradic current. This feature is of especial importance and requires considerable care and observation. When the branches are thus isolated they are easily injected with alcohol with a fine needle from the ordinary hypodermic syringe.

The third operation is planned for the relief of overaction of the gastrocnemius group. The muscles here involved are mainly the gastrocnemius and soleus which are supplied by branches from the internal popliteal nerve.

Operative Technic.

Incision two inches long, made longitudinally over the center of the popliteal space, and carried downward through the fascia between the two heads of the gastrocneminus to the internal popliteal nerve. The branches which supply the soleus and gastrocnemius are isolated by careful electrical stimulation and injected with an alcoholic solution.

The fourth operation is designed for the relief of spasticity affecting the anterior tibial group through its nerve supply from the anterior tibial nerve.

Operative Technic.

Through a longitudinal incision one and one-half inches long over the head of the fibula, the external popliteal nerve is easily exposed at its bifurcation into the peroneal and anterior tibial

Case IV, Group I.—Cerebral quadriplegia showing marked adductor and hamstring spasticity.

nerves; it is best to identify the nerves by a careful electrical stimulation. The anterior tibial is then injected with an alcoholic solution.

Case IV.—C. D., twelve years of age, December 19, 1908, cerebral quadriplegia. General condition of paralysis noticed

shortly after birth. Has made little progress mentally, though he understands simple questions and is able to form single words intelligently. Has never walked. General condition has been good. Family history good, except that mother had a form of facial paralysis. Examination, December 19, 1908, showed a well developed and fairly well nourished boy. Intelligence that of a child of three years of age. No deformities of skeleton. Nothing abnormal about abdomen or thorax. Because of automatic movements of lower muscles of face he has peculiar grimaces and foolish expressions. Spine normal. Upper extremities spastic from tips of fingers to shoulder-joints; lower extremities held in marked adduction, knees crossed, legs flexed on thighs 45 degrees, foot in position of slight dorsal flexion, and toes plantar flexed. Spasticity of adductor groups is very marked, resisting attempts at passive correction. The knees cannot be extended beyond 20 degrees flexion. Hamstring groups are particularly spastic and contracted. Attempts at passive movements at ankle-joints bring on spasticity, especially in extensor groups, and the foot is moved into slight dorsal flexion with toes plantar flexed, the great toe overlapping the two next it. In the feet and hands are automatic movements similar to those described in the face. Standing position: Can almost maintain balance, weight is borne on internal borders of feet, not including heel, with legs crossed, the left knee anterior to the right knee, the right knee resting on the calf of the left leg, flexed 45 degrees. Thighs flexed on trunk 35 degrees. Trunk fairly erect, but the arms are engaged in many excited movements in the attempt to maintain balance. In attempting to walk both legs are moved rapidly by automatic irregular movements of two sorts, described as movements of attempted progression which are cork-screw in character and are produced voluntarily. During this attempt the boy's face is contorted and his arms are very spastic, the whole being accompanied by foolish laughter, grimaces, and inarticulate sounds.

December 21, 1908.—Operation under ether; through the incisions described above, the obturator nerves were exposed on both sides without difficulty, and injected with an 80 per cent. solution of alcohol. It was found immediately after this operation that both thighs fell into a position of abduction. Recovery good.

December 26, 1908.—Boy had no temperature. Thighs are abducted 15 degrees and there is no spasm in the adductor groups. General condition good.

December 29, 1908.—Operation under ether; wounds of first operation found to be healed, except for a small space at the lower end of the incision on the right side which has granulated. Stitches

removed. The patient turned on face and posterior aspect of both thighs prepared for operation. Anesthetic administered. Knees held tightly flexed at 50 degrees flexion. Two and a half inch incision, running downward from the fold of the buttock over the course of the sciatic nerve. This nerve trunk was exposed by blunt dissection on the right side first. The branches given off to the internal hamstrings first discovered and injected with 60 per cent. alcohol. Later the branch to the biceps picked up, also injected. Spasm of the hamstrings has diminished so that toes touch the table, a marked contrast in spasticity between the right and the left. Same procedure employed on the left side with a similar result. Wounds closed with silver wire subcutaneous stitch. Good recovery. It is now found that the lower extremities are abducted 20 degrees and flexed at the knee 15 degrees instead of 50. It is to be noted when the patient was recovering from his anesthetic that he was able to slightly abduct both thighs.

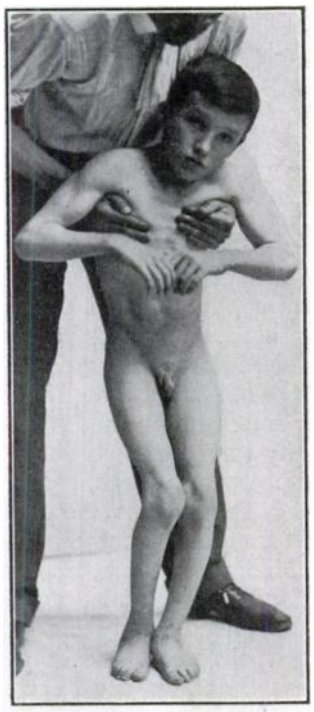
January 5, 1909.—Patient's wounds have united by first intention; general condition good; boy is able to stand and coordination is markedly improved.

April 29, 1909.—Patient bears his weight upon his legs with knees slightly flexed. He steps decidedly and slowly, and tendency to overaction is much diminished. Coordination in arms and legs have decidedly improved.

CASE V.—N. G., twelve years of age, cerebral diplegia, Little's disease. At the age of nine months the child had scarlet fever, and parents date his trouble from that time. He learned to walk slowly and his intelligence has been only fair. Patient gets about with assistance, but has a cross-legged gait. Well-developed and fairly nourished boy, head square and large, expression dull, intelligence good, can spell, write, and do simple sums of arithmetic; heart and lungs normal, upper extremities normal. Lower extremities are spastic, held in 20 degrees adduction with right knee advanced over left, spasticity of hamstrings causing 20 degrees flexion at knees. These contractures can be overcome to a certain extent by pressure and force. Knee-jerks abnormally increased, Babinski sign present on both sides, Achilles jerk plus. Gait: By holding to a chair or table boy can travel around the same, doing so with a marked spasticity of lower extremities, evidenced by adductor contraction, flexion at the knees, and eversion of the feet. The right knee is first held in front of the left and an attempt is then made by swinging the trunk to advance the left knee which is done slowly and with difficulty.

June 15, 1909.—Operation under ether; incision made on the

right side over the anterior aspect of the thigh at the internal borders of the adductor muscles, and carried down through the superficial fascia; muscles made out, and an attempt made to discover the obturator nerve and its exit into the ramus of the pubis. After one and one-half hours' time, this search was unsuccessful and the wound closed. The nerve was considered to have either an abnormal course or to be undiscoverable by the operator. At



CASE V, GROUP I.—Cerebral diplegia (Little's) showing adductor and hamstring spasticity.

all events it must have received some surgical injury, for the thigh at the end of the operation was abducted 30 degrees and there was very little spasticity in the adductor group. Recovery good.

June 19, 1909.—Operation on left side, ether; incision was made in the usual manner and the obturator nerve was exposed in less than 10 minutes' time, having a normal course. Was injected with 80 per cent. alcohol and electrical stimulation was employed to make out its conductivity. After the injection

this was found to be lost, a strong faradic current being used threw the other muscles of the thigh into a state of tetany which lasted twenty minutes. Wounds closed with silkworm gut. Recovery good. Operative wound at first operation healed by first intention. After recovering from the anesthetic it was found that both thighs were in a position of 30 degrees of abduction, no spasm of the adductor muscles on either side.

July 15, 1909.—Operation, ether; secondary operation done on the right side. The obturator nerve discovered after some difficulty. Injection after the usual manner and the usual result. Wound closed with silkworm suture. Good recovery.

July 22, 1909.—Operation, ether; patient placed prone upon the table, back of thighs prepared for operation. Longitudinal incision made over each thigh, four inches long. Sciatic and its branches readily exposed. Each branch was picked up, stimulated with mild faradism to find out what muscle or muscles it supplied. Injected with alcohol and conductivity retested. This procedure was done on the branches to the biceps, the semimembranosus and semitendinosus, and a branch to the abductor magnus. Wounds closed with silkworm gut. Good recovery. Two hours after the operation no spasms of hamstrings. Complete extension of the leg is voluntarily possible. Wound of second operation on right side shows primary healing.

August 1, 1909.—Leaves hospital, gait improving daily.

September 29, 1909.—Boy is going to school; legs still weak but uses them well; feet placed squarely on floor, with no tendency to adduction or flexion deformity; is having daily training. Walks alone without support and gait is improving.

CASE VI.—L. F., thirteen years of age, cerebral quadriplegia, October 1, 1909. Mother states that child walked normally until the fifth year, when she had a fright and a fall and was injured by a horse. Following this there was progressive loss of power in her legs, so that when she was seven years of age she was no longer able to stand or walk. Her hands then became involved so that she could not use them. Her mental condition has remained about the same. She is able to understand her mother and to make attempts at speech. When asked to sit up she endeavors to do so. During the last year she has had several epileptiform attacks with loss of consciousness. She has grown normally and her general health has been good. She has control of bladder and rectum, and has good appetite, sleeps well, and is of a pleasant disposition. Well developed and fairly nourished girl, imbecilic, drolling expression, with intelligence that of a child five or six years. Is unable to stand, to walk, or to use her arms on account of

spastic contractures. As the patient lies in bed the legs assume position of flexion at the knees, flexion at the hip, with the spasticity more marked in the left than in the right. The adductor spasm can be seen best when the legs are forcibly abducted. Owing to the contracture at both knees the overadduction is not so clearly in evidence. The right foot is in extreme pronation with extension in the three outer toes; athetoid movements present. The left foot is in marked supination. The calf muscles feel soft and flabby in spite of their evident spastic contractures. This is due probably to the fact that the muscles have never been used for walking. There is a shortening of the Achilles tendon in both legs, likewise of the flexors at the knees. Owing to the contracture and the spastic condition surrounding the joints the knee-jerks could be obtained only with difficulty and were pathologically plus. On account of the mental condition of the child no attempt at sensory examination was made.

October 2, 1909.—Operation with ether; excision made over the external popliteal nerve on left leg. Nerve discovered without difficulty and its bifurcation into the anterior tibial and musculocutaneous made out. By an electrode these nerves were positively determined. The anterior tibial on this side was injected with 60 per cent. alcohol and its conductivity tested; found to be lost. On the right side the same procedure was put into effect, with the difference that the musculo-cutaneous was injected instead of the anterior tibial. Through two long vertical incisions on the back of the thighs the sciatic nerves were laid bare and the branches to the hamstrings were injected. Wounds were closed; good recovery. After the operation it was found that the right foot had no longer peroneal spasticity. The left foot is held in clubbed position but not due to muscular overaction. The spasm of the hamstrings has completely disappeared.

October 5, 1909.—At 2.00 A. M. patient died of double pneumonia, with a temperature of 109°.

CASE VII.—Spastic hemiplegia, with slight congenital hydrocephalus. A. A., three and one-half years of age, April 9, 1908. Child is one of five children. Was born when mother was forty-one years of age. Instrumental delivery was necessary which left a scar upon the forehead. Child was nursed at breast, but has always been weak. Dentition normal. Walked at the age of one and one-half years. It was then noticed that child limped with right foot and held right arm in a peculiar way. This condition has increased since. Mentality is above the average and her general health has always been good. First consultation showed a large flabby child with good mentality. On right side

of forehead is a scar from instrumental delivery. Heart and lungs are normal. Expression slightly stupid. Head large and of hydrocephalic appearance. The right foot is held in supination and plantar flexion, the tendo Achillis contracted. There is a slight contraction at the knee. The gait is that of spastic club-foot.

Treatment.—April 20, 1908. The tendo Achillis was divided and the foot was placed in a right angle position in plaster-of-Paris. Child made a good recovery and after three weeks walked with very much improved gait. Observation has extended over the period of time between this operation and the present.

October 4, 1909.—The spasticity in the whole right extremity has returned. There is overaction of anterior tibial and gastrocnemius groups in the right foot and 20 degrees flexion at the knee, due to spastic hamstrings. There is a slight tendency to spasticity in the left lower extremity. Child's general condition has improved, health is good, and she walks about in a lively manner but with this disability. Reflexes increased, more on the right. The contractures can be overcome by steady pressure; that is, the knee can be straightened and the foot can be brought to a right angle, straight position with the legs, but no further.

October 11, 1909.—Operation, chloroform, with patient on face. A longitudinal incision was made on the posterior aspect of the thigh, laying bare the upper half of the great sciatic nerve. The branches to the semimembranosus, semitendinosus, and abductor magnus were injected with 60 per cent. alcohol, also the branch to the biceps. Incision closed with subcutaneous silver wire stitch. Over the popliteal space a longitudinal incision was made which laid bare the branches of the internal popliteal nerve which supply the gastrocnemius and soleus; three in number. Electrical stimulation was employed to identify these nerves. Sixty per cent. alcohol was injected into their sheaths. Incision closed with subcutaneous silver wire stitch. Through a longitudinal incision over the head of the fibula the external popliteal nerve was exposed and its bifurcation into the musculocutaneous and anterior tibial nerves made out. The anterior tibial was injected with alcohol and the wound closed with subcutaneous silver wire stitch. Time of anesthetic one hour. Recovery good.

October 15, 1909.—Discharged from hospital, all wounds healed by first intention, no temperature.

March 14, 1910.—Spasticity of hamstrings has entirely disappeared. There is still overaction of the anterior tibial group,

also of the gastrocnemius. This is attributed to faulty technic. A secondary operation is planned.

CASE VIII.—Cerebral diplegia, Little's disease, D. L., six years, eleven months, October 20, 1909. Seen first on October 13, 1905. Family history is negative. Child was born prematurely; weight 4 pounds. At the time of first observation child was twenty-seven months old. Has been under the care of a doctor for malnutrition and has gained weight and strength. Child is able to speak a few words. Spasticity was noticed in the right arm and leg. The mental development has been below normal. Says "mamma," "sister," and "papa." Weight 23 pounds. Examination showed spasticity in legs, more marked in the right, with plus knee-jerks, no clonus, no Babinski. The legs are freely movable as are likewise the arms in passive motion, but a spastic condition develops and is easily observed. The child is only able to hold its head up for a moment or so; cannot stand unless supported. When held up the legs become adducted in a cross-legged position.

Seen again at three years of age, November 9, 1906. Patient is not able to stand, attempts to rise up in a sitting position with more vigor than at the last examination.

November 9, 1906.—Well developed and well nourished child. Back weak, both legs spastic, and arms spastic. Overaction of both tendo Achilles and hamstring groups.

November 10, 1906.—Operation under ether; both tendo Achilles divided subcutaneously, feet confined at right-angled position with legs in plaster-of-Paris bandages. Recovery good. To be supplied with ankle braces and jacket.

November 25, 1906.—Sent home. Mother instructed to encourage child to take the initiative in walking and using his muscles.

May 19, 1908.—Seen in consultation with Dr. E. H. Bradford of Boston. Child walks with feet on floor, slight pronation, slight flexion of toes, stands with support requiring aid in balancing. Back is still weak, sits erect for a few seconds with head correctly posed, but relaxes and falls forward. There is marked spasm of the adductor groups of muscles and slight spasm of the hamstrings. Advised to discontinue braces and have child associate with playmates and be educated in attempting to walk.

September 27, 1909.—When placed on his back child makes a good attempt to rise by flexing the whole body at an angle of 20 degrees. The spasticity in the lower limbs is very evident. There is marked adduction spasm, producing cross-legged position. Child is able to stand with support. The feet are flat on the floor

and there is no spasticity in the gastrocnemius group. He can sit alone with spine flexed in a long posterior curve, the head held fairly erect. Mental condition markedly improved, general nutrition good. Parents advised to bring child to the city for a period of six months.

October 20, 1909.—Operation under ether; through two incisions over the anterior aspect of both thighs at the usual point; the obturator nerves were easily found and isolated. Injected with 80 per cent. alcohol. Time of operation, forty minutes. Child's condition after the operation, good. Legs abducted to 50 degrees, spasticity of adductors has entirely disappeared.

October 29, 1909.—Patient discharged from hospital. Wounds healed.

January 1, 1910.—Child has been doing systematic daily physiologically planned exercises, with massage. There has been marked improvement in initiative. He now attempts to make steps. Supports himself in standing and all tendency to adductor deformity has disappeared.

April 1, 1910.—Educational exercises have been continued daily. Child is now able to make certain voluntary movements and to hold himself upright in sitting. As yet he is unable to balance or to stand alone.

CASE IX.—Cerebral diplegia, Little's disease. M. M., two and one-half years of age, March 17, 1910. Birth was normal and child presented a normal appearance. As it became older mother noticed that lower limbs were held stiff. Mentality has been slow in its development. Can say only a few words and expression is vacant. Has never made any attempt to walk but can stand with slight support. Well developed and well nourished child, marked spasticity of both lower extremities, legs held adducted. When child is placed upon its feet the spasm of the adductor muscles and of the gastrocnemius groups is very marked, producing cross-legged flexed knee position.

March 17, 1910.—Operation under ether; through an incision over the anterior aspect of thigh, just below Poupart's ligament, the obturator nerve was easily discovered and isolated on both sides. Into them was injected 60 per cent. alcohol. This was followed immediately by loss of conductivity demonstrated with the electrode, and by the thighs assuming an abducted position. Wounds closed with silver wire subcutaneous sutures. Recovery good.

March 30, 1910.—Wounds healed by first intention, child leaves hospital in good condition. All tendency to adductor deformity has disappeared. There is no spasm of adductor

groups; gastrocnemius group slightly overactive, also hamstring. Mother instructed in physiological exercises.

In summarizing the results obtained in this group of cases it is necessary to point to the fact that we are dealing with a class of congenitally defective individuals, so far as the nervous system is concerned, and that the results of operative procedures must be given in terms of improvement only. Furthermore, the mortality following operation is due to the lessened resistance characteristic of the congenitally defective; for example, the two cases that resulted fatally (Cases II and VI) died of double lobar pneumonia, though the operation was in neither case prolonged nor productive of shock. With this explanation in view we believe the following results are a just estimation of the effectiveness of muscle group isolation in the treatment of spasticities:

One case of cerebral hemiplegia with athetosis: athetois stopped, paralysis unaffected.

Four cases of cerebral diplegia (Little's disease) markedly improved: one of these to the extent that walking and coordination are practically normal; two cases relieved of cross-legged progression and put into a position where the proper educational exercises will develop a coordinate gait; the fourth relieved of adductor overaction and still under treatment.

One case of quadriplegia, very extensive in character and with extreme overaction of stronger muscle groups; standing impossible. This case after operation was able to stand and has since made considerable improvement under properly designed exercises. Walking has not been accomplished without support.

One case of spastic hemiplegia with slight congenital hydrocephalus in which there was overaction of the hamstring group, the gastrocnemius group, and the anterior tibial group. Here, the operation was effective in overcoming the overaction of the hamstrings. The overaction of the gastrocnemius group, due to faulty technic, has not been checked, but the gait is much improved.

Two cases died after operation, from pneumonia.

Cases I, II, and III in the above list were reported in detail in our preliminary paper (The Surgical Treatment of Athetosis

and Spasticities by Muscle Group Isolation, Schwab and Allison. *Journal of Nervous and Mental Diseases*, Vol. XXXVI, No. 8, August, 1909).

Group II.

In the second group we have a total of four cases operated upon.

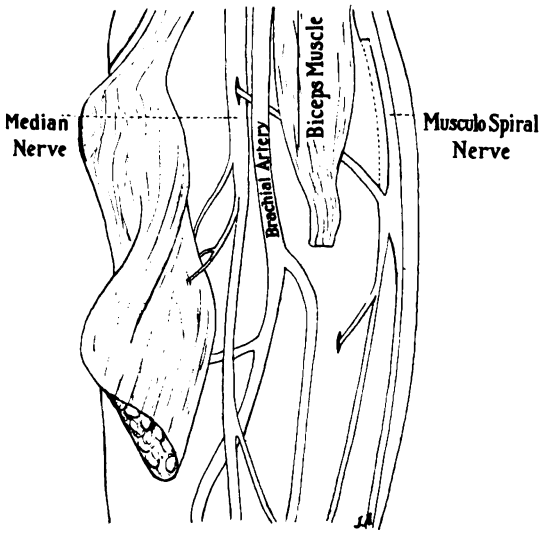
1. Traumatic paralysis of musculospiral.
2. Poliomyelitis anterior. Paralysis of quadriceps extensor.
3. Poliomyelitis anterior. Peroneal paralysis with overacting anterior tibial group.
4. Poliomyelitis anterior. Peroneal paralysis with overacting anterior tibial group.

The first two cases in this group are reported to show the efficiency of nerve anastomosis properly performed, and have their bearing upon the problem under consideration in that nerve anastomosis serves an important purpose in carrying out an essential step in an operation of which muscle-group isolation is the complement. This operation was used in Cases III and IV of this group. In them the antagonist group overacting at the expense of the flaccidly paralyzed group produced deformity. Nerve anastomosis alone would have been insufficient unless the unequal pull had been rendered powerless by temporarily throwing the overacting muscle out of activity. This was accomplished by alcoholic injection of the nerve supplying this muscle group.

Case I.—Traumatic paralysis of musculospiral. T. T., twenty-one years of age, June 16, 1909. On February 17, he was riding in the doorway of a caboose attached to a lumber train. The door was open and of a sliding character; leaning out of the doorway, his right arm and right leg over the sill, the train struck a boulder and came to a sudden stop, throwing the sliding door against his right arm and right thigh, fracturing the femur and injuring his arm. Well developed and well nourished young man, heart and lungs normal, general physique good. Right femur: Small discharging sinus on inside of thigh, union good with deformity. Right arm and forearm: There is a characteristic wrist-drop, lack of power to supinate, lack of power to extend the wrist, typical musculospiral palsy. The biceps muscle apparently crushed in two, one-third of it forming a promi-

nence just above the elbow-joint, the upper two-thirds retracted to one inch above the middle of the arm Triceps power and brachialis anticus power good. The divided ends of the biceps are also enervated. The humerus in uninjured. There is considerable wasting of the muscles of the forearm and shoulder.

June 17, 1909.—Operation under ether; a longitudinal incision was made over the posterior external aspect of the arm, carried down between muscular septa to musculospiral nerve. Just below the groove there is a thickening in the nerve. Electrical stimulation applied along the course of the nerve causes contraction of



CASE I, GROUP II.—Diagram of operation showing anastomosis between the musculospiral and median nerves.

the brachialis and triceps. No response in muscles of the forearm or wrist. Sheath of the nerve freed and the wound closed with interrupted silkworm-gut sutures. Ruptured biceps sutured with animal tendon.

July 3, 1909.—All the wounds have healed by first intention. Electrical stimulation (faradism) produces no reaction either in nerve or muscles on the extensor side of the arm.

July 7, 1909.—Patient is up and about and examined daily with electricity to discover any tendency toward reestablishment of nerve function. Up to the present time there has been no improvement. Biceps united.

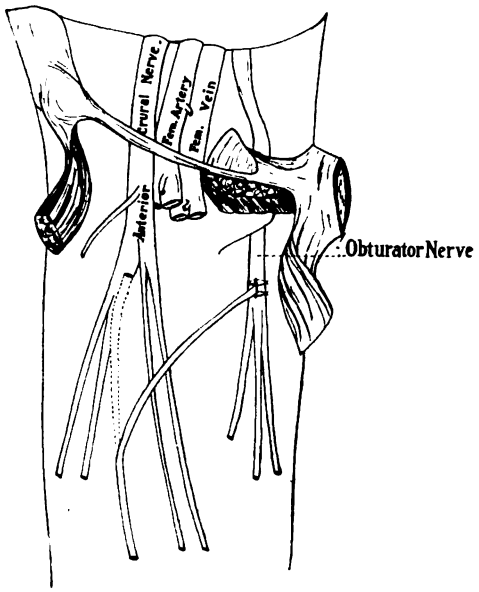
July 13, 1909.—Operation under ether, incision was made over the course of the musculospiral nerve, following line of former incision, carried anteriorly over the elbow-joint down to the muscle. The musculospiral nerve exposed does not respond to direct electrical stimulation. It was divided in its middle for a distance of 3 inches longitudinally and the inner half cut free at the upper extremity of the longitudinal cut. This segment carried under the biceps tendon and inserted into the median nerve and sutured in place with ∞ catgut. Wounds closed. Through a longitudinal incision over the dorsum of the forearm the extensor tendons of the wrist were shortened, placing the wrist in extreme extension. Both wounds closed with silver wire subcutaneous stitches. Plaster-of-Paris applied, holding forearm flexed, hand extended. Good recovery.

July 23, 1909.—Paster removed. Wounds have healed by first intention. There is absolutely no power of extension of the wrist or fingers. Patient supplied with a tin split which can be applied to the arm, holding the forearm flexed and the wrist and fingers extended. There is no reaction to faradism in nerve or muscle.

November 11, 1909.—Patient can hold wrist extended and use his crutch on that side with very little difficulty. Examination of the muscles supplied by the musculospiral nerve: There is only a minimum amount of paresis at the wrist. The hand is held almost horizontal with a slight indication of wrist-drop, produced largely by fatigue. There is a definite extension movement at the wrist and fingers. This movement can be observed with the arm flexed at the elbow. The extension at the elbow is as good as it has always been. Stimulation of the musculospiral at the usual place over the triceps muscle gives a slight reaction of the triceps. Below the injury, however, galvanism of this nerve produces no response. Galvanic stimulation of the extensor group of muscles gives a very definite response in the middle finger and to a lesser extent in the other fingers. This extensor response can be shown by the movement of fingers and by the actual movements of the tendon and by palpation as well. It seems from this examination that the extensor response at the wrist and at the fingers has returned and the conclusion is justified that the anastomosis of the median and the distal part of the musculospiral has been to this measure successful.

April 27, 1910.—The forearm is held pronated and there is some disability in supination. There is considerable power in extending the wrist and extending the fingers. Along the anatomical course of the musculospiral nerve strong faradism gives

only transmitted effect on the flexor side of the hand, forearm, and wrist. There is no extensor response whatever. Over the site of the anastomosis, at the median surface of the arm, along the inner border of the biceps, stimulation with a light faradic current gives prompt extension of the fingers, thumb, and wrist. Stronger current here produces in addition normal flexion. This demonstrates that impulses along the extensor tract in the arm are transmitted through the median nerve and that the remnant of the musculospiral react no longer to electrical stimulation. There is normal ability to use the hand and forearm.



CASE II, GROUP II.—Diagram showing nerve anastomosis between obturator nerve and quadriceps extensor branch of anterior crural nerve.

CASE II.—Poliomyelitis anterior. Paralysis of quadriceps extensor. W. W. K., six years of age, November 13, 1909. Eighteen months ago boy had a typical attack of poliomyelitis from which he recovered so that he could walk in about a week. General physical condition good, mentality is above the average. Heart and lungs are normal, skeleton normal except for 1/2-inch shortening of right lower extremity. Musculature is normal except right lower extremity. Here there is absolute loss of power in the quadriceps extensor. The sartorius has power, the adductors are normally strong, and there is some power in the abductors.

Hamstring group weak but active. All muscles in right leg are functioning but weak. There is power to extend and flex the foot on the ankle, also to supinate and pronate the foot. He walks by swinging the right leg on the right thigh with a slight limp, characteristic of quadriceps extensor paralysis.

November 16, 1909.—Operation under ether; longitudinal incision made over the anterior aspect of thigh in line of femoral vessels, 4 inches long, anterior crural nerve exposed. The branch running to quadriceps group picked up by electrical stimulation. This branch was cut off from the main trunk high up in the wound, passed under the nerve, artery, and the vein. The obturator nerve was then exposed and the branch of the anterior crural was introduced into a longitudinal cut in the trunk of the obturator nerve and there sutured with two strands of oo catgut. There was no tension upon the anastomosis. The wound was closed with a deep catgut suture and a silver wire subcutaneous stitch. Good recovery.

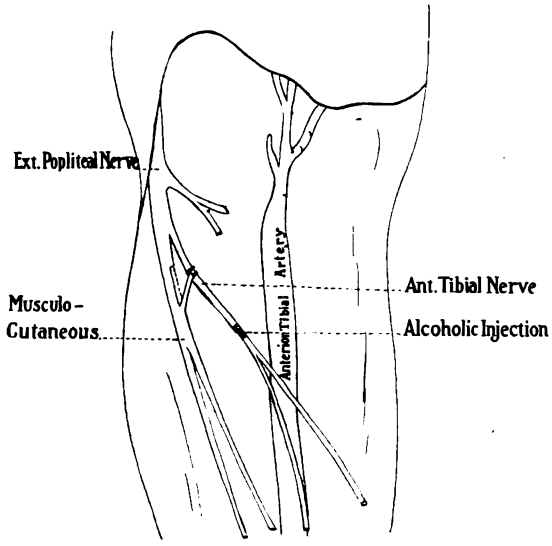
April 24, 1910.—The quadriceps extensor is faradically excitable, both at the motor point and in the course of the muscle itself. There is a visible and palpable contraction of the patella. Power is not yet sufficient in the quadriceps to hold the leg extended on the thigh against the force of gravity, but in walking there is marked improvement in gait, the swing of the leg on the thigh being very much lessened.

CASE III.—Poliomyelitis anterior, peroneal paralysis with overacting anterior tibial group. E. S., nine years of age. Has always been a healthy child, except for trouble of her left lower extremity. Two years ago without apparent illness, so far as her parents' observation extended, she lost the use of her entire left extremity. It was slightly painful and tender. After a time muscular power began to reappear.

April 30, 1909.—Muscles are all good except in left lower leg, where the peronei, with the exception of the peroneus tertius, are powerless. In walking the foot is held in marked supination. The plantar fascia is contracted as is the gastrocnemius. The anterior muscles of the leg; *i.e.*, tibialis anticus, extensor communis digitorum and the peroneus tertius have fair power. The peroneus longus and brevis do not act. All the other muscles of the leg are normal. There is 1/2 inch atrophy of calf.

May 3, 1909.—Operation under ether; incision made 3 inches in length, vertical in direction, over the outer aspect of the leg, having its middle point opposite the head and neck of the fibula. This was carried to the muscular layers and the external popliteal nerve was exposed in the wound. Faradic stimulation of this

trunk caused a quick contraction of the extensor communis digitorum, tibialis anticus, and the peroneus tertius. The nerve was further exposed and its bifurcation into the anterior tibial and musculocutaneous made out. Faradic stimulation of the musculocutaneous, 1/2 inch below the bifurcation, produced no response whatever in the peroneus longus and peroneus brevis. Stimulation of the anterior tibial nerve, 1/2 inch below the bifurcation, produced a similar strong contraction to that described above. The musculocutaneous nerve was divided 1/4 inch below the bifurcation in a longitudinal direction. This cut end



CASES III and IV, GROUP II.—Diagram of operation on musculocutaneous and anterior tibial nerves. Nerve anastomosis plus muscle group isolation.

of the nerve was then inserted in a vertical slit made in the anterior tibial nerve, 1/4 inch below the bifurcation, and was sutured with two strands of oo catgut. One-half inch below this nerve anastomosis in the course of the anterior tibial nerve, 10 minims of 80 per. cent alcohol were injected into the sheath of the nerve. Faradic stimulation of the anterior tibial nerve gave no response in the group of muscles which it supplies. The wound was closed with silver wire subcutaneous stitch. Recovery good.

May 10, 1909.—Wound healed by first intention.

September 17, 1909.—Child has had daily electrical stimulation since last note. Foot examined shows power to abduct, using the peronei to a noticeable extent.

November 13, 1909.—The foot is held in a much improved position with the outer edge fairly well raised. Voluntary motion is restricted to slight movement and extension of the toes. There is slight movement of the outer edge of the foot. Tibial group is active. Stimulation of the musculocutaneous nerve by galvanism gives a response which can be seen and felt by the movement of the peroneal tendons.

CASE IV.—Poliomyelitis anterior, peroneal paralysis with overacting anterior group, B. McL., eight years of age, May 20, 1909. At two years of age had indefinite history of an attack of paralysis. Since then both legs have been involved. Has had various forms of treatment, but not of an operative character. Well developed and well nourished girl. General health good, trunk and upper extremities normal. Right thigh abducted 10 degrees, flexed 10 degrees, 15 degrees of flexion of leg on thigh, foot held in marked plantar flexion and supination. Left thigh flexed on trunk 40 degrees, abduction 30 degrees, externally rotated 50 degrees, marked shortening of psoas and iliac-tibial band, leg flexed on thigh 25 degrees, foot in marked plantar flexion and slight inversion. Muscular power: Hamstrings on right side strong; on left side weak, but have power. Quadriceps extensor on right side weak; on left absent. Gastrocnemius group, right side strong; left side power absent. On the right side there is some power in tibialis anticus and extensor longus hallucis. The peronei on both sides show no muscular power. There is a slight power of dorsal flexion and of extending the great toe. The left foot shows no power in the anterior group of muscles, in the peronei or gastrocnemius group.

May 21, 1909.—Operation. Considering the completely paralyzed condition of the left lower extremity, it was decided to place this limb in a corrected position by division of tendons, delaying operative interference until deformity is corrected. Upon the right side, considering the pull of the anterior group of muscles and the lack of power in the opposing group, it was decided to attempt a nerve anastomosis and a blocking-off of the relatively stronger group by an alcoholic injection similar to that which was done in Case III with variation. An incision was made similar to that in Case III, carried down to the muscles and the external popliteal with its two divisions (anterior tibial and the musculocutaneous) were exposed. Stimulation of the musculocutaneous caused no peroneal contraction; stimulation of the anterior tibial caused contraction in the anterior group of muscles. Peroneal group of muscles were pale and atrophied, but did not show any evidence of degeneration. The musculocutaneous nerve was

split for a distance of 1/2 inch longitudinally in its course and 1/2 inch below the bifurcation of the external popliteal. A cut was made horizontally at the upper end of this split, and half of the nerve fibers were turned to the inside. A slit was made in the anterior tibial nerve opposite this nerve division and severed end inserted and sutured with a fine catgut suture and the wound closed over the anastomosis with a second fine catgut suture. Below this anastomosis, on the anterior tibial nerve, an alcoholic injection was made into the nerve sheath. This immediately produced a relaxation of muscles supplied by the anterior tibial nerve, allowing correction of the deformity. Wound was closed with silver wire suture. Tendo Achillis was divided subcutaneously. The limb incased in plaster-of-Paris, with the foot in a corrected position. Good recovery.

November 13, 1909.—Strong faradism over the site of the external popliteal nerve produced in the peroneal tendons a weak contraction. Also there is some ability to evert the foot. This, however, is very weak and is over-pulled by the anterior tibial muscles as well as by the tibialis posticus.

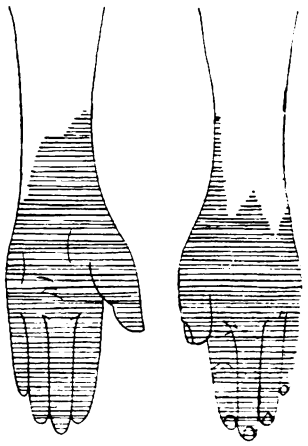
In summarizing the methods used and the results obtained in the second group of cases, attention is called to the absolutely favorable results which followed simple nerve anastomosis, illustrated in Cases I and II. These results reenforce the idea upon which the combination of operation is based; that is, in order to have an effective transference of nerve impulses from a sound nerve to an injured nerve the opposing factor of antagonist muscle pull must be eliminated (this has long been recognized). Furthermore it is essential to point out emphatically that the good results reported in the literature obtained through the agency of tendon transference and elongations serve to strengthen the plan of operation which has been done in Cases III and IV. Given the amount of power which would insure a good result by any mechanical method whatever, a much more perfect result may be obtained by a proper conservation of the muscles and tendons intact and an utilization of nerve anastomosis plus properly applied muscle group isolation. Cases III andG IV illustrate this point.

Group III.

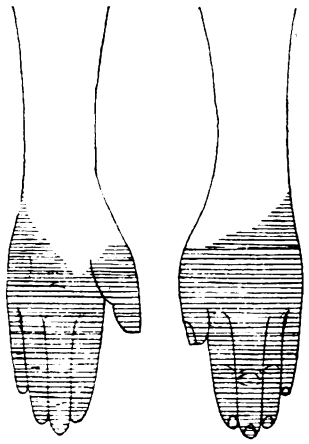
In the third group we have one case to report. It is illustrative of the wide extent to which the method of induced paralyses can

be applied. It further illustrates the fact that the total nerve supply of a segment of the body, including both sensation and motion, can be cut off by means of nerve alcoholization without subsequent trophic disturbance.

CASE I.—J. H., thirty-two years of age, family history negative in respect to his present trouble. About 8 years before first observation the patient, working in a brush factory, noticed jerking movements in his left arm and hand. These jerking movements at first were comparatively infrequent in the course of the day, but later increased in extent and in variety until work was impossible for him. For the past three years he has been unable to do any work.



CASE I, GROUP III.—Diagram showing area of anesthesia immediately after operation, October 30, 1909.



CASE I GROUP III.—Diagram showing area of anesthesia, April 7, 1910.

November 2, 1909.—There is a peculiar and complicated group of movements, limited largely to his left side; that is, to the whole of the left arm, to the shoulder, and to the neck muscles on the left side. The origin of this movement is vague, and perhaps has had something to do with his former trade—that of a brush-maker. The movements so duplicated the physiological arrangement of cortical muscles in the arm that a temporary diagnosis of Jacksonian epilepsy was made, the diagnosis being based largely on the successive groupings of the movements of the arm. This movement, which we have come now to believe is a tic, is somewhat as follows:

In the first place the movement, to a certain extent, is under the control of the will; that is, it can be started apparently by the patient himself, but once begun he seems unable to control it. The movement begins by an extension of the fingers and thumb, and is followed by flexion of the wrist, by a contraction of the extensors of the forearm, by which the hand and arm are thrown clear of the body. At this point the flexed hand is seized by the right hand and forcibly extended. With this forcible extension of the wrist the whole arm becomes a bit stiffened from the elbow down, and is thrown by the right arm away from the body. The muscles of the upper arm and shoulder now engage in the movement and the arm is finally brought at rest, adducted, and flexed at the elbow and at the wrist. The movement is performed quickly, sharply, and accurately, never varying in the slightest, occupying thirty seconds to a minute or a minute and a half. There is never loss of consciousness, there is no pain or discomfort in the movement. When the movement was first observed, the muscles of the neck, the deep muscles, and the sternocleidomastoid were not concerned. These have lately been involved and there has been quite marked rotation of the neck with the chin to the left and intense muscular spasm. When the patient was first seen the diagnosis lay between Jacksonian epilepsy and a complicated tic. An effort was made at training the patient.

Then an operation was done over the right cortical area on the chance that there might be some cortical source of irritation. At this operation through a large flap the middle of the Rolandic area was laid bare. With a mild faradic current the area of the fingers and thumb and the forearm were picked out to determine accurately the location of the motor center. After the dura was opened, nothing abnormal was discovered, except a group of markedly tortuous veins, practically varicosities, lying at the upper limit of the Rolandic area. These were ligated. The patient's arm was enclosed in a plaster-of-Paris bandage after the operation, and as long as the plaster bandage was intact the tic movements were not observed. Shortly after the plaster dressing was removed, however, the movement returned with much of its former severity. The diagnosis now seems undoubtedly that of tic. As an additional argument in favor of this diagnosis, can be cited the fact that the patient seemed to be more comfortable after the movement takes place and seems rather expectantly awaiting the impulse, whatever it may be, for the movement to take place.

October 21, 1909.—Operation, ether. Through a median incision over the belly of the biceps muscle, above the flexure of the elbow, the median nerve and the musculospiral nerve were

exposed and injected with 80 per cent. alcohol. Their lack of conductivity was demonstrated with faradism. Through a longitudinal incision over the internal condyle the ulna nerve was drawn up to the wound, also injected with 80 per cent. alcohol. Wounds closed with subcutaneous catgut suture. Good recovery.

October 29, 1909.—Patient discharged from hospital. Wounds healed.

No definite conclusion can be given concerning this case, as it is at the present time under observation. It may be said, however, that the tic movements have totally disappeared as would be naturally expected, on account of paralysis of the distally involved muscles. The other muscles which took part in the tic movement and which were unaffected by the operation do not show any evidence of abnormal or uncontrolled movements. The case is further of interest in regard to the whole question of paralyses produced by alcoholic injections of the nerve from the point of view of trophic disturbance and the length of time of regeneration. Concerning the trophic functions of the nerves involved there has been an interesting and unexpected feature in this case, although, as can be seen from diagrams, there is a total lack of sensation in the region supplied by the three nerves injected. The patient showed no positive signs of trophic disturbance. About three months after the operation the patient received a severe burn on the back of his fingers. This healed as quickly as would a similar burn on a normal hand. The return of sensation is extremely slow in this case. It is now six months after the operation and the demarcation between normal sensory areas of the skin and those affected by the operation show only slight variation from the first examination. Although this might seem slow, yet its constant though small increase shows that there is a marked and positive tendency toward sensory regeneration. Up to the present time there is no evidence of motor regeneration whatever. On the other hand, there is very little tendency toward atrophy of the muscles supplied by the injected nerves.

DISCUSSION.

DR. SCHWAB, opening the discussion, expressed his appreciation of having been asked to attend the meeting and, in a brief way, commented on the

work that he and Dr. Allison had been doing for the last three years. He wished simply to emphasize two or three points that were probably not very clearly understood.

The alcohol injections in spastic cases, he said, are not curative. All that the authors had attempted was temporarily to throw out of action the antagonistic muscle. Meanwhile, the opposing group is exercised, so that by the time the original nerve regenerates the muscular force has been somewhat transferred to the opponent group. The obturator muscles can be so strengthened that when regeneration takes place the leg will be held in better position and walking be facilitated. He wished to be considered as speaking from the neurological point of view, rather than the orthopedic. Even when the regeneration is not complete, he said, the advantage is that in these operations the patient can be gotten out of bed within a few days. There is no necessity for the use of a plaster cast or for putting the patient on his back for a long time. He and Dr. Allison had had their patients walking about the ward a few days after the operation. Considering the class of patients on whom they had operated, he thought this a great advantage. Their assumption was that athetosis, spasticities, and were of the same nature. When they injected the nerves with alcohol the athetosis completely disappeared and did not return. Whether athetosis is of so much importance from the orthopedic point of view, however, as from that of the neurological he did not know. He stated that two or three operations had been done in Chicago, with the same results.

In the second group of cases, the operation of throwing out of action the antagonistic pull was very effective; by the time the nerve regenerated the antagonizing group had not regained its original strength, so that the condition was more hopeful of future cure than by any other method.

While the third class of cases, tics, might not have the same amount of orthopedic interest, many cases can be attacked in a much better way than ever before by surgical treatment. They paralyzed the whole distal group of affected muscles in one case of the most remarkable tic movements, and the tic disappeared. It was assumed that there had been produced a sort of motor amnesia of this movement.

Of greater interest, perhaps, from the standpoint of the alcoholization of nerves was the fact that while three nerves were alcoholized and there was complete anesthesia to touch and pain, no trophic disturbance appeared in any part of the arm. The man accidentally burned himself but this burn healed just as quickly, without suppuration, as it would have done in an ordinary person.

DR. B. E. MCKENZIE, of Toronto, asked Dr. Allison to tell the Society some particulars regarding the technic of the operation and the strength of alcohol used in the injections. He thought that the authors had omitted to state in their paper just what strength of alcohol they used.

DR. G. G. DAVIS, of Philadelphia, said that it would be interesting to find

something curative in the treatment of these cases. Treatment by tendon division had been criticized as being devoted to the tendons, and not to the nervous system; but Dr. Davis thought that the treatment to the nervous system was the same, practically, as that to the tendons. Neither method had been curative, so far as he knew; and no curative means had been proposed. To his mind, the alcohol injection of nerves was similar to the division of nerves: after the nerves unite, they resume their functions; and after the effects of the alcohol disappear, the nerves also resume their functions.

Dr. Schwab had said that the nerves do not resume their functions absolutely. To that extent, Dr. Davis believed the alcohol injections to be an advance. Even in division of the tendons, however, some permanent good is done. He thought it a question whether the new method constituted any real improvement. He did not think that a sufficient number of good results had yet been shown to demonstrate that the regeneration of the nerve does not take place entirely, or to what extent it fails to return. Dr. Nutt's case last year was one in which he divided the sciatic nerve. This had a local effect, and also to a limited extent a secondary effect on the general condition. Therefore, it might be considered superior to operation on the tendon.

Coming to other means of treatment, Dr. Davis said that in treatment by nerve anastomosis a longer time must also elapse before its value can be determined. Spiller and Frazier, three or more years ago, anastomosed the brachial plexus with that object in view. As soon as the spasmodic group is thrown out of action, improvement takes place. At first there is absolute paralysis of this group, then an interval of more or less paralysis; after this the muscle begins to resume its ascendency. This is what he understood had occurred in Frazier and Spiller's case; in other words, there is a resumption of the original condition. He trusted that this resumption of the original condition was not complete, but said that he would like to have further evidence. He thought that more than two years should elapse before one could judge of the value of these procedures.

DR. VIRGIL P. GIBNEY, of New York City, thought that the Association ought to feel under lasting obligation to Drs. Allison and Schwab for bringing forward anything helpful in the treatment of cases of spastic type. A month before Dr. Gibney had seen Dr. Murphy, of Chicago, inject osmic acid into the facial nerve for the cure of tic. Dr. Murphy had remarked that this procedure would give relief for twelve months and that the tic would then return, and said that alcohol would not serve so good a purpose in the facial nerve; in nerves farther removed from the center of circulation, however, he thought that alcohol would serve the purpose better, putting these nerves out of commission for a long time. Dr. Gibney thought that any member of the Association who has had these cases to treat would welcome nine or ten months' surcease from spasticity. At the end of this time, the injection could be again made, and the patient given a rest for nine or ten

months more. He did not see any objection to using the alcohol every nine or ten months. He thought it better than plaster, no matter how much one loves the latter. Putting a large child in plaster in spread-eagle style so that it requires two beds is very troublesome, even if there is a hope of putting the muscles out of commission by this method. If these gentlemen, by attacking the nerves, could destroy them for any number of months, as they had claimed, Dr. Gibney thought that the opposing muscles could be developed in the interval, which could not be done when a plaster cast is employed. If the children can go around, he said, their education can be carried on; so he considered it a wonderful advance in the therapeutics of spastic paralysis.

DR. WALTER G. STERN, of Cleveland, referring to the cases of athetosis and especially to the case of Drs. Frazier and Spiller, mentioned by Dr. Davis, said that whatever operation may be done on such a case, the athetosis will return after a while; even if one should amputate the arm below the shoulder, the shoulder would move. When Dr. Stern spoke to Dr. Frazier after the reading of that paper, he mentioned that he had himself done such an operation as theirs, but the nerve had regenerated; nerve to nerve anastomosis was successful, and after a month or two sensation returned; a year or so passed, and athetoid motion again returned. He was not so blessed with his operation as Drs. Frazier and Spiller were with theirs: their patient is worse, but his own is a great deal worse.

DR. ALLISON, closing the discussion, said, in reply to Dr. McKenzie's question regarding the strength of the acohol used, that they varied the strength to a certain extent. He did not know just what per cent. should be used, but stated that Dr. Schwab and himself were then engaged in some experiments for the purpose of determining this point. They had found that some cases have a more lasting paralysis than have others. He thought that the percentage of alcohol might have something to do with this. It must be at least 50 per cent., in order to have any effect at all; and he had used straight alcohol in some cases