The treatment of paralytic deformities / by Robert W. Lovett.

19.

The Treatment of Paralytic Deformities

BY

ROBERT W. LOVETT, M.D.

Reprinted from the Boston Medical and Surgical Journal
Vol. clxii, No. 15, pp. 479–485, April 14, 1910

BOSTON
W. M. LEONARD
101 TREMONT STREET
1910

THE TREATMENT OF PARALYTIC DEFORMITIES.*

BY ROBERT W. LOVETT, M.D.

THE treatment of paralytic deformity by means of tendon transference has, in the last ten years, been constantly before the medical public, and the literature of the subject would fill volumes. Yet, at the French Congress of Surgery, in 1907,[1] where the subject was discussed by the men in Europe best equipped to speak with authority, a difference of opinion existed as to the value of the operation,[5] although the majority of the surgeons agreed as to its value. For this reason, in spite of the accumulated literature, the subject cannot be considered closed for further consideration.

In formulating the subject of the treatment of paralytic deformity for presentation to you I have been somewhat embarrassed as to the best course to pursue; there is no need of a routine discussion of the operation with a relation of my own operative results, for that has been done many times and by the best men. I have no new experimental data to bring forward, nor is there great need of such until we have digested better those at our command. But from the lack of papers on this especial aspect I have thought that perhaps the time was not inopportune for a general survey of the whole question of the treatment of paralytic deformity, non-operative and operative. I shall, therefore, call to your atten-

* Presented before the Orthopedic Section of the Sixteenth International Medical Congress at Budapest, Aug. 30, 1909.

tion in the following paper the fact that the operative is merely one aspect of the whole question of the treatment of paralytic deformity which, for the time being, has overshadowed the other aspects of the subject to their detriment. To the importance of these other aspects I shall direct your notice especially in their relation to tendon transplantation.

The paper will first deal with the varieties of paralytic deformity and of the need of their proper recognition and analysis as a basis for any effective treatment. Then will be presented the prevention of paralytic deformity. The question of treatment will be considered first in its non-operative and secondly in its operative aspect. The conclusions which I shall present will consist, first, of the results of the experience of my colleagues and myself in operative and non-operative treatment at the Children's Hospital, Boston, where, from 1883 to 1907, inclusive, 1,225 cases of infantile paralysis applied for treatment; and, secondly, it seemed to me desirable to present with regard to tendon transplantation a consensus of the opinion of my fellow members of the American Orthopedic Association, to whom I have addressed a circular to which they have replied. From these various data, which are larger than any one man's operative experience would be, and from the literature of the subject, I shall then present certain conclusions.

My paper will deal wholly with the deformities due to anterior poliomyelitis, and in the space at my disposal principles rather than details must be dealt with.

A. Varieties of Paralytic Deformity.

As paralytic deformity arises from various causes, it occurs in various forms. Intelligent

treatment, operative or mechanical, must start with an analysis of the cause and character of the deformity.

The varieties are as follows:

1. A DISTORTION DUE TO GRAVITY IN A WHOLLY PARALYZED AND FLACCID LIMB.

A leg is wholly paralyzed, and in sitting and lying the foot drops into a position of plantar flexion from the leverage of the unsupported foot. This is the earliest type of distortion to be seen, and exists from the outset of the disease. It perhaps should be spoken of as a malposition or distortion rather than as a true deformity.

2. AN ADAPTIVE SHORTENING AND LENGTHENING OF THE PARALYZED SOFT PARTS INDUCED BY MALPOSITION.

If the above or any similar malposition continues uncorrected for months, an adaptive shortening of the relaxed soft parts and an adaptive lengthening of the stretched muscles, ligaments and joint capsule may occur, so that the former become permanently shortened and the latter permanently lengthened. The foot is held in this instance in a position of talipes equinus, but reposition is not possible; a permanent fixed deformity has developed. In the arm a similar condition is to be seen when a paralysis of the arm and shoulder has occurred and the head of the humerus, no longer supported by muscles, is dragged down and away from the glenoid cavity by the weight of the arm.

3. A SHORTENING OF NON-PARALYZED AND A LENGTHENING OF PARALYZED MUSCLES.

If the anterior muscles of the leg, or most of them, are paralyzed, and the posterior escape

injury, the non-antagonized healthy muscles will by virtue of their tonicity draw the foot into a position of equinus and hold it there, and shortened muscles will, in time, become permanently contracted, although not paralyzed, while lengthened muscles will become permanently stretched, and a fixed deformity will result. It can be predicted in advance, in most instances, what a definite muscular paralysis will produce in the way of deformity. From the study of 635 cases from the Children's Hospital, Boston, the following table of deformities of the foot was formulated: [2]

Deformity.	Resulting from paralysis of
Varus,	Peronei.
Valgus,	Anterior tibial.
	Posterior tibial.
	Both tibials.
	Flexor longus hallucis.
	Whole leg (weakened).
	Complete paralysis.
Equinus,	Anterior muscles, paralyzed or weak.
	Complete paralysis (from dangling).
Equino-varus,	Anterior muscles (with persistence of flexor longus hallucis).
	Anterior and external group.
	Paralysis apparently complete (probably toe flexors remaining).
Equino-valgus,	Anterior and internal muscles.
	Anterior muscles and weight-bearing.
Calcaneus,	Posterior muscles.
Calcaneo-valgus,	Posterior muscles and one or both tibials.
	Other instances of this type of deformity are flexion at the knee and flexion at the hip.

4. A STATIC DISORTION FROM WEIGHT-BEARING IN PARALYZED OR PARTLY PARALYZED LIMBS.

If a leg is paralyzed, or partly paralyzed, below the knee without great disturbance of muscular balance, and the patient is able to bear weight on

it, the unsupported foot then rolls into a position of valgus, and stretched soft parts become lengthened and shortened ones contracted, making a fixed deformity. Another instance of this type of deformity is to be found in the relaxed and hyperextended knee accompanying cases of extensive thigh and leg paralysis.

5. A FIXED DEFORMITY OF THE TRUNK RESULTING FROM AN EFFORT TO SECURE EQUILIBRIUM.

A deformity of the trunk, expressed as lateral curvature of the spine, results from paralysis of some of the muscles of the back, from paralysis of the shoulder muscles and at times from paralysis of the leg which leads to shortening or imperfect function. As a result of these diverse causes, to maintain equilibrium, an asymmetrical position of the spine is necessary, which, in time, becomes fixed. That this is not purely the result of the action of unantagonized non-paralyzed muscles as in variety [3] is shown by the fact that in paralysis of the muscles of the right side of the back, e. g., the convexity of the lateral curve, is sometimes to the right and sometimes to the left.[3] If this deformity were the result of the action of the non-paralyzed muscles it would always be convex to the same side in the paralysis of the same muscles.

6. BONY DEFORMITY FOLLOWING PERSISTENT MALPOSITION.

A complication or sequence of all of these forms of distortion or deformity is to be found in the permanent bony deformity which must occur if the malposition remains uncorrected during the years of growth. Bone is an adaptive structure, and notably so while developing, because in its growth it follows the line of least resistence. The

bones of the foot, for instance, develop normally only when the foot is normally used and a persistent valgus, e. g., is followed by a distortion of the individual bones of the foot to the type familiar in the valgus of adults.

7. DISLOCATION FROM INFANTILE PARALYSIS.

This must be recognized as a further deformity of a wholly different type, affecting chiefly the hip and shoulder. It is too extensive a subject to be entered on here and the literature will be found in the reference.[4]

B. THE PREVENTION OF PARALYTIC DEFORMITY.

The prevention of deformity is too little insisted on, and it is probable that the occurrence of serious fixed deformity is, except in paralysis of the spine and shoulder, always unnecessary. A competent orthopedic surgeon would be ashamed of the occurrence of fixed deformity of the foot, e. g., in any case under his control from the early stage of the affection, yet most cases of infantile paralysis sooner or later acquire some deformity. In any discussion of paralytic deformity it is a very serious part of our business to educate the general practitioner, the surgeon and the neurologist to the point of recognizing such deformity as in general an evidence of neglect.

Having analyzed the varieties of paralytic deformity with regard to their causes, it is easy to see what conditions we must guard against in our preventive measures. These may be grouped in the general statement that we must, in prevention, antagonize persistent malposition from any cause, because this leads to adaptive shortening and lengthening of soft parts and to distorted

bony growth if continued. In other words, it tends toward fixed deformity.

Simple gravity distortion (variety 1) may exist from the outset, and the deformity of genu recurvatum has been reported by Townsend [5] as observed on the second day in two cases. Our preventive measures must, therefore, be begun early. This point of early fixation has been particularly emphasized in the recent New York epidemic.[6]

From the outset the dropped foot must be held day and night at a right angle to the leg by splints of wood, tin, iron, plaster of Paris or celluloid, and thus supported until the limitations of the paralysis have been cleared up by the spontaneous improvement of the first three months.

This fixation and support accomplishes three ends:

1. It prevents functional activity in muscles whose centers have just been involved in a hemorrhagic myelitis.

2. It promotes the recovery of muscles which are not wholly paralyzed and which, without support, would be stretched and, therefore, at a disadvantage as to recovery.[7] Moreover, non-paralyzed muscles may be so stretched by persistent malposition as to become functionless. The prevention of such stretching, therefore, promotes the welfare of non-paralyzed, partly paralyzed and completely paralyzed muscles, as well as preventing the stretching of ligaments and joint capsule.

3. It prevents the occurrence of contractions in the soft parts which would be shortened by the malposition, by preventing the malposition.

After the acute stage is over and the stage of established paralysis is entered upon, the pre-

vention of malposition is quite as important as it was at the outset. If, in standing, the foot rolls over into varus or valgus position, if the knee becomes hyperextended, if the spine curves to one side, these malpositions should be prevented by accurate fitting braces, or corsets, which maintain as nearly as possible the normal position and the normal relations. In regard to this the point is at times urged that braces cause muscular weakening, promote muscular atrophy and prevent the free and unrestricted use of the muscles which is necessary for their welfare, and that a little deformity, more or less, is not a serious matter. It is true that braces are objectionable and always to be avoided when possible, but permanent deformity and stretched muscles and ligaments are still more objectionable. The unrestricted use of the muscles in a partly paralyzed leg where such unrestricted use means malposition and unbalanced function is of little importance compared to the harm done. From the point of view of the orthopedic surgeon, therefore, who better than any one else knows the late history of infantile paralysis, the importance cannot well be overstated of supporting from the outset of the disease, so long as necessary, the paralyzed limb in its normal position and enabling it to perform, as nearly as possible, its function in its normal relations.

C. Treatment of Paralytic Deformity.

For the relief of paralytic deformity we have two methods of treatment at our disposal: (1) The mechanical, and (2) the operative; both supplemented by a third therapeutic measure, the development of the muscles by massage, electricity and muscle training.

Mechanical, operative and developmental treat-

ment are not here to be sharply separated either in theory or practice because most operative cases require mechanical treatment after operation and many before it, and development of muscles is an adjuvant of all treatment.

1. MECHANICAL TREATMENT.

By mechanical treatment we can stretch some shortened tissues, we can shorten some lengthened tissues, we can influence the growth of the deformed part toward the normal, in all of these ways tending to restore normal muscular balance and consequently to improve function. Moreover, we can support flaccid and functionless limbs in a position to permit useful function, and we can, by supporting braces, prevent static deformity in the knee and foot.

Stretching of Contracted Tissues.

Moderate contraction of the soft parts may often be relieved by manipulation with the use of moderate force, either with or without anesthesia, and retention by means of plaster of Paris bandages in an over-corrected position. This treatment is applicable to mild degrees of talipes equinus, equino-varus and valgus, to flexed knees, to scoliosis, etc.

As to the relative merits of cutting and stretching and their combination, that must rest on the judgment and preference of the surgeon in the individual case. What I wish to call attention to are the possibilities contained in mechanical measures now too often overlooked. The length of time over which such over-corrected position, either after simple or operative correction, may be maintained with benefit has been estimated at many months.[8] One of my colleagues in the

American Orthopedic Association, a man of the widest experience, wrote me, " Very many cases operated upon by tenotomy and *long-continued* immobilization give as good functional results as tendon transplantations."

Aside from such correction by means of plaster of Paris bandages, braces and apparatus may be used to stretch contracted soft parts. For example, the Taylor varus shoe will frequently correct moderate talipes-equinovarus; a valgus shoe with raised sole plate, by the use of leverage, in the same way may correct valgus deformity, and a flexed knee may often be straightened by a backward pull to two side uprights.

Shortening of Lengthened Tissues.

The phenomenon is seen in the cure of hyper-extended knees with the strain on the back of the knee is relieved by apparatus which can later be dispensed with. Gibney [9] pointed out that if talipes calcaneus is by plaster of Paris sufficiently long retained in an over-corrected position some shortening of the calf muscles occurs. It is a frequent experience in this connection to see a talipes equinus with no apparent power in the anterior leg muscle below the knee. The tendo Achillis is cut to remedy the deformity and after three or four weeks' fixation at a right angle it is found that some power has returned to the anterior muscles which before were stretched and functionless. Of course, there could have existed only partial paralysis, but partial paralysis is common and function has thus been restored where it was absent before. The fact has been largely overlooked that some of the benefit following tendon transplantation is due to fixation of some weeks in an overcorrected position and consequent shortening of lengthened soft parts.

Influence Toward Normal Growth by Apparatus.

That the continued wearing of accurate, properly fitted and effective apparatus can, in a measure, be depended on to influence growth toward the normal would seem to be a statement not requiring extended comment. Such a principle finds its best application in scoliosis, which is not amenable to other treatment, in deformities of the feet in young children, and in older children where operative correction is undesirable.

In our consideration of mechanical treatment we must remember that very many cases of infantile paralysis are not to be benefited by operation on account of the extent or character of the paralysis. We must remember, also, that operative measures must, in most instances, be preceded and supplemented by mechanical treatment. It is worth our while, therefore, as orthopedic surgeons, not to slight the importance of mechanical treatment, but to dwell on the importance of such treatment carried out by light, accurate and effective braces. In the American orthopedic surgery of to-day there is too little attention paid to the art of brace fitting, as exemplified in the work of C. Fayette Taylor and Shaffer.

2. OPERATIVE TREATMENT.

This consists first (*a*) in *tenotomy*, *myotomy* and *fasciotomy* of contracted soft parts for the improvement or removal of fixed deformity. This is followed by fixation in the over-corrected position for two to four weeks at the least, and in many cases for an indefinite time with benefit (see above). The operation is performed either subcutaneously or by the open method. The procedure requires no extended consideration.

(*b*) *Osteotomy* may be required in severe cases for the amelioration of knock-knee of high degree, for knee flexion and rarely for severe distortion of the foot in advanced cases. Apart from the mere correction of deformity, three further operative measures aim at improvement or restoration of function.

These are:

(*c*) Tendon transference.

(*d*) Arthrodesis, tenodesis and silk ligaments.

(*e*) Nerve grafting.

(*c*) *Tendon Transference.*

The operation, as is well known, consists in the transference of the tendons of one or more unparalyzed muscles in an affected limb to the insertion of, or tendons of, paralyzed muscles, thus utilizing the muscular power remaining in the limb to better advantage by substituting the contractile power of the healthy muscles for those which have been lost and thus restoring or improving function. The transplanted tendon may be attached to a paralyzed tendon,[10] or to the periosteum, or be anchored by being passed through a hole drilled in the bone,[11] or be extended by means of a silk prolongation, which is, in turn, attached to periosteum.[12]

The technic of the operation has been elaborated and formulated by Hoffa,[28] Lange,[12] Vulpius,[10] Codivilla,[29] and others[30] and will be found described in the references and not dwelt on here.

My contribution to the subject of tendon transplantation will, as was said at the opening of the paper, consist, first, of a presentation of the conclusions reached at the Children's Hospital, Boston; and, second, of a consensus of the opinion of my American Orthopedic colleagues.

The first represents the results of the operation

on children under twelve, performed during a series of years beginning in 1895 in one institution by the hospital staff on a homogeneous group of cases under similar conditions.

The second represents the experience in several hundred operative cases of the leading orthopedic surgeons in America, operating in widely separate parts of the country, on different classes of cases.

I have avoided in both instances the presentation of statistics, because, as pointed out by Redard,[1] they are of little value for the reason that the cases reported are unlike, they are of varying grades of severity, operated on by different methods and judged by different standards. They cannot, therefore, be relied on for comparison with each other.

Children's Hospital Results.

At the Children's Hospital the early operations were not as satisfactory as have been the later ones. The operation was a new one, the hospital was a pioneer in the matter, and, as in other instances,[14] the first cases operated on naturally contained a larger number of unsatisfactory results than were seen later.[15] Yet, in a series of cases operated between 1895 and 1905, in a group where the ultimate results were known, 68% of these reported improvement from the operation, this group representing on the whole the earlier and middle [16] operations.

In the earliest operations the results were less satisfactory for the reasons:

1. That tendons were united to tendons and often stretched.
2. The period of post-operative fixation was too short.
3. The transferred tendons were not attached with sufficient tension.

4. Unprotected use in walking was allowed too soon.

5. The importance of careful after-treatment, especially by muscle training, was not sufficiently appreciated.

6. The previous correction of deformity was not properly carried out.

7. Our cases were not selected for operation with as much judgment as they now are, because of our lack of experience in first performing the operation.

8. In addition to these defects, which are comparatively easy to formulate, our whole method in plan of operation, after-treatment and other respects suffered in little ways from lack of practice in performing a new operation.

We had at no time much trouble with infection, except when we first began to use silk tendons and ligaments, when, for a while, we had difficulty at times with sloughing out of the silk, a matter remedied by an improved technic.[17]

In the last few years our ultimate operative results have been as satisfactory as they were in the beginning unsatisfactory.[18] The chief changes in our methods have been as follows:

1. Operative cases have been selected with more skill and studied with greater care from our larger experience with operative results.

2. The correction of existing deformity has been better carried out.

3. Tendons have been inserted into periosteum, and tendon-to-tendon attachment has been abandoned.

4. The use of silk extensions has proved satisfactory and has given an added range and flexibility to the operation.

5. The transferred tendons have been attached with such tension that when the limb was held

in the over-corrected position they were moderately tight.

6. The period of fixation now in use is from six weeks to three months.

7. After the fixation plaster is removed, a supporting brace is worn until six months or a year after operation.

8. From the time of the removal of the fixation plaster, massage and muscle training of the transferred muscles is followed out in cases where the patients live near enough to the hospital to avail themselves of it.

9. Simple operations have been preferred to complicated ones, and the splitting of a muscle and its use for two insertions has been largely abandoned and the entire muscle transplanted.[13]

10. The use of silk ligaments in the ankle-joint as supplementary to tendon transference has proved of the greatest value.[19]

In some instances the results are brilliant; in some, the extent and character of the paralysis prevent us from obtaining as good functional results as we would desire. We know of no case in our series made worse by operation.

Under these conditions we now regard the operation in *suitably selected* cases as one strongly to be recommended to patients, and in the great majority of such cases as one followed by most satisfactory results.

Results of Circular of Inquiry to American Orthopedic Surgeons.

A circular of inquiry was sent to each active member of the American Orthopedic Association, in answer to which my colleagues have sent me careful, clear and suggestive résumés of their experience and opinion.

The circular sent was as follows:

"1. Do you consider tendon transplantation in properly selected cases a useful and satisfactory operation?"

The replies were as follows:

Yes,	34
Yes, qualified,	2
Moderate,	3
In some,	1

The opinion is thus definitely expressed that it is a satisfactory and useful operation in suitably selected cases.

"2. Are your end results satisfactory?"

The replies were as follows:

Yes,	13
Yes (in carefully selected cases),	7
Moderately,	7
No,	7
Sometimes, relatively or partially,	8

One suggestive comment was made by a surgeon of large experience, who stated that there was an element of uncertainty in the end results not to be wholly accounted for, some of his best results occurring in cases with inadequate after-treatment and some of his least satisfactory in cases where every care was taken.

"3. Do you prefer tendon-to-tendon suture or periosteal implantation?"

The replies were as follows:

Periosteal implantation (one of these also tunnels the bone),	28
Tendon-to-tendon suture,	5
Both methods used,	5

"4. What in your experience are the most frequent causes of failure to obtain good results?"

(As most circulars contained several heads to this reply, the total is in excess of the number replying.)

Improper selection or poor operative plan,	20
Insufficient after-care,	17
Failure to overcorrect deformity,	7
Infection,	7
Insufficient tension,	7
Poor technic,	3
Substitution of weak muscles,	2
Operation on too young children,	3
Tendons too short or poor attachment,	3
Stretching of tendon, tendon too freely stripped, use of catgut, failure to tunnel properly, pull not straight,	1 each

"5. Are your more recent operations more satisfactory that your earlier ones were?"

Yes,	31
No,	5
The same,	1

From comments made in the replies it seems that this improvement is due to two causes: First, the more careful selection of cases leading to fewer operations; and, second, improved operative technic and better after-treatment.

Causes of Failure.

The three common causes of failure after tendon transfer may then be formulated as follows, named in the order of their frequency:

1. Selection of unsuitable cases for operation and insufficient study and analysis beforehand to permit a proper operative plan.
2. Insufficient or improper after-treatment.
3. Failure to over-correct deformity before operation for tendon transfer.

Other and less frequent causes of failure which may occur when the operative technic has been good and the after-treatment adequate are as follows:

1. The attached tendon may stretch [20] or pull away from its insertion.[21]

2. Adhesions binding the transferred tendon to surrounding soft parts may occur.[22]

3. Where tendons have been split and utilized for two purposes, the two halves may not functionate separately.

4. The transplanted muscle may be too small to perform its new function.[23]

5. The tendon may turn a corner and not pull in a straight line, due to insufficient freeing of it or to insufficient tunneling of the soft parts.[24]

6. The operation may have been performed at too early an age or too soon after the onset of the paralysis (under two years after attack).

7. The tension of the transferred muscle may be too little.

8. Lengthened muscles may not have been sufficiently shortened.

The fact has been largely overlooked that muscular lengthening is much more difficult to remedy than is muscular shortening, and in the neglect of this fact is to be found the explanation of some failures after tendon transference. The results of the reefing of paralyzed tendons in connection with tendon transfer have not in our hospital cases proved very satisfactory. Jones attempts to guard against muscular stretching by the removal of an ellipse of skin in the flexure of the paralyzed joint and uniting the edges.

Finally, there are certain general considerations in connection with this operation which, it seems to me, have not been sufficiently regarded. The paralysis itself is not affected by the operation, but the same muscles remain powerless that were powerless before. If deformity existed, it was due to a certain cause, which cause still in large measure exists. We are generally not operating on a foot, for example, which is normal except for the loss of one, two or three muscles, but on a foot

which, by the loss of one, two or three muscles, has become distorted and unbalanced. These are all factors which must be taken into account in our operative plan if we are to secure good ultimate function, and the tendency to recurrence of the deformity must inevitably be a strong one.

3. DEVELOPMENTAL TREATMENT.

The question of the general usefulness of developmental treatment will not be here discussed, but simply its advisability after tendon transference.

With the transfer of a non-paralyzed muscle to a new insertion, a new line of pull, and probably a new tension, after which transfer a period of fixation lasting some weeks has necessarily followed, it becomes obviously necessary to bring to bear on this muscle all means at our disposal to enable it to recover its nutrition and function which have been impaired by the fixation. The three agencies at our disposal are electricity, massage and muscle training.

Electricity. — The use of electricity is admirably defined by Sachs.[25] (Except as a matter of exercise, electricity is practically useless.) The opinion of certain orthopedic surgeons as to its practical value may be found in the reference.[25]

Massage. — Massage is to be regarded as a means of improving the nutrition and muscular tone of the transferred muscle and of stimulating the circulation of the entire limb.[26]

Muscle training. — Muscle training is coming to occupy the prominent place in our therapeutics that it deserves and is superior to either of the two measures mentioned. It represents an attempt to secure a motor impulse which is transmitted through the motor cells controlling the especial

muscle by means of which a contraction of the transferred muscle is secured. Frequent repetition of this process (1) educates the muscle to contract in its changed relations; (2) it leads to improved nutrition from activity; (3) repeated often enough, it tends to developmental hypertrophy of the exercised muscle.

As a therapeutic measure it has the advantage of directness in being exactly what the muscle has got to do in restoring or improving function. But if moderate developmental use is desirable, an excess of this by overloading the muscle is undesirable and leads to relapse. Hence the need of protected and supported use of the early function under weight bearing. C. Fayette Taylor forty years ago pointed out this danger. "To extend a muscle while in the act of contracting, that is, to overcome it, is at once to destroy its irritability and force." [7] "To perform a tendon transfer, fix the leg in plaster for some weeks until muscular atrophy has become marked and then to allow walking unprotected is bad treatment. Unless the operated leg is massaged from the sixth week on, and the newly transferred muscle is trained to its new function shortly afterward, and unless this massage and training are carried over some weeks, the best results cannot be expected. No matter how good the operation, it must be followed up or the operation of tendon transfer will be regarded by the individual operator as a much over-estimated procedure; if, on the other hand, he performs a sound and reasonable operation and has his patient properly treated over a period of about six months, he will find it, in a large proportion of cases, one of the most satisfactory procedures in operative surgery. No importance can be attached to published results of tendon grafting unless there is

published at the same time an account of the after-treatment. If it is lacking, poor results are explained." [2]

The discussion of arthrodesis has been assigned to Mr. Robert Jones, and I omit the subject entirely along with the allied subjects of tenodesis and the use of silk ligaments. The operation of nerve anastomosis as yet has hardly emerged from the experimental stage, and its consideration would require a paper by itself. I therefore omit the subject here, giving the chief authoritative works in the reference.[27]

Conclusions.

No summary is possible of a paper which is, at best, only a résumé of a very extensive subject and I must content myself in closing with the mere mention of those points which seem to me of most importance.

The treatment of paralytic deformity must consist of a combination of mechanical, operative and developmental measures. If we emphasize too much one aspect of the subject at the expense of the others, our treatment loses in efficiency.

At present the operative aspect, as exemplified in tendon transference, overshadows the other element; this has resulted in a certain proportion of failures leading to the question as to the value of tendon transference as an operation.

This is largely because the operation, being new and easy to execute, has been performed on too many cases, many of which were unsuitable; it has often been done by those not cognizant of the need of supplementary mechanical and developmental measures, and by many who, although cognizant of the need of these, were not able to follow them out.