Original Articles.

MUSCLE AND TENDON TRANSFERENCE.

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The following paper is based upon an analysis of 35 cases, with periosteal insertion and silk strand elongation, including one case of silk suture elongation of the hamstring to the os calcis, and two cases of pectoral trapezius anastomosis.

This procedure in surgery has already won its position in the list of surgical methods, but as there is still much discussion in regard to the question of technic, the careful recording of cases is at present desirable. The following cases are presented as indicating the results which can be obtained by the exercise of ordinary care.

The writers record their appreciation of the great value of the method of extending tendons by the use of silk strands. They wish to emphasize the necessity of the following points: First, the avoidance of disturbance of tissues as far as possible; second, the necessity of thorough asepsis, not simply such as is ordinarily necessary in surgical procedures, but in the preparation of the skin.

Silk strands have been, as a rule, used after having been boiled twice; in some instances the second boiling has been in a corrosive sublimate solution, in others, the simple boiling has been employed. They have not found that any particular advantage has followed, as far as they can determine, the boiling in sublimate claimed by Lange to be essential. As the number of cases is not large, definite claims cannot be made, but it is clear that the danger is not as great from silk not boiled in sublimate as has been suggested.

The dipping of the sterilized silk in solutions of celluloid has been used in one instance, and the method is open only to the objection of increasing detail.

The patient's skin has in two instances been protected with the ordinary means of sterilization by painting with iodine, and afterwards by painting with a solution of rubber in ether over the field of incision. This latter was applied to one limb, and where the other limb was also operated on the ordinary means of sterilization were all that were used. No perceptible difference was noted in this instance, and in the other cases the method was not used in order to avoid multiplication of details.

It is seen that in some of these cases a healing by first intention is not obtained. It can, however, be claimed that such a rule is regarded as desirable in all instances, and can be attained by the most careful attention to detail. It is for that reason, probably, that it is desirable, even at the expense of the multiplication of details, to carry out most thoroughly means for skin sterilization and for other sterilization.

It is desirable that the patients should be kept in a plaster fixation for as short a time as possible, plaster only being applied for a sufficient length of time to secure a healing of the skin incision, and a reasonably strong tissue healing.

After this the apparatus treatment should be begun, with apparatus devised in such a way as to prevent any strain upon the transferred tendon. Massage, muscle training and graded exercises are essential in the after-treatment for several months.

It cannot be claimed that a complete restoration to normal strength can be accomplished in tendon transference. In many instances little can be accomplished, as it is impossible to transfer muscles effectively, if there are no strong muscles to be utilized; but in the larger number of cases considerable benefit can be obtained, and in a certain number surprisingly good results can be secured.

The method of tendon arthrodesis, as described by the writer in an article presented to the society two years ago, has been performed three times. The ultimate result after three years in one case was extremely satisfactory; a sloughing out of one strand delayed the cure in the second case, and in the third case the final result cannot be determined, as the operation has only been recently performed but in both cases excellent results are promised.

An analysis of cases of tendon transference chiefly without silk strand elongation, treated at the Boston Children's Hospital for the previous ten years, was reported two years ago.

The following cases are additional ones, operated upon by the writers, both at the Children's Hospital and elsewhere, with the transference of tendons lengthened by silk strands.

TENDON TRANSFERENCE WITH SILK ELONGATION FOR DEFORMITIES OF THE FOOT.

CASE I. J. B., age, ten years. Operation, Sept. 7, 1905. Infantile paralysis, requiring transference of the tibialis posticus and a portion of the flexor communis digitorum into the scaphoid and cuboid for paralytic equino-varus. The result early in the year 1906 was good, with power of dorsal flexion and good adduction. The patient walks without apparatus.

CASE II. M. M., age eight and a half years. Operation August, 1905. Paralytic calcaneus. Wedge section of the os calcis, with the transference of the tibialis posticus with an insertion on the calcaneus. Silk elongation. Results, Nov. 14, 1905, good position.

CASE III. E. L. R., age eight years. Operation, September, 1906. Infantile paralysis with foot drop, requiring transfer of two slips of common extensor of toes to cuboid, and two other slips to the inner side of the foot inserted into scaphoid. Result, better position, without gain in motion.

CASE IV. M. O., age seven years. Operation September, 1905. Peroneus longus and one half of the tendo Achillis into anterior part of astragalus by means of silk.

Result, in good position of foot. Has not reported recently to ascertain motion.

CASE V. M. W., age ten years. Operation August, 1906. Paralytic varus requiring the transfer of two slips of extensor of toes by silk into periosteum of cuboid, and removal of a wedge from the outer part of os calcis.

May, 1907, the foot is held in good position and has gained in motion and function. (Fig. 1.)

CASE VI. J. K. B., age five years. Operation Aug. 8, 1905. Half of the tendo Achillis was split and

brought forward and inward by silk elongation into the scaphoid. The result, when last examined, was good as to position and use.

CASE VII. F. B., age eight years. Operation Aug. 11, 1905. For paralytic equino-varus. Half the tendo Achillis was brought forward to the scaphoid and cuboid by tendon transference with silk elongation, shortening of the tibialis anticus and peroneus longus. Result, good position and functional use.

CASE VIII. R. C., age nine years. A similar condition justifying a similar operation Aug. 16, 1905, with an excellent immediate result. March 19, 1907.

CASE IX. A. F., age ten years. Operation August, 1905. Equinus; insertion of half of the tendo Achillis elongated by silk strands into the scaphoid. Good result in motion and position. March, 1907.

M. W. CASE V. FIG. 1.

Transference of flexor communis digitorum, with silk strand insertion on inner and outer sides of dorsum of the foot to correct front foot drop.

Other view of Fig. 1, showing the regained power of raising front of foot.

CASE X. E. R., age nine years. Operation Aug. 22, 1905. Insertion of a portion of the flexor communis digitorum and a portion of the tendo Achillis into the scaphoid and cuboid by silk elongation; stretching of the hamstrings. Result, good position, and more motion. March, 1907.

CASE XI. W. M. K., age eight years. Operation Aug. 22, 1905. For equino-valgus. Transference of a portion of the flexor communis digitorum and of the tendo Achillis to the scaphoid by silk elongation, with tenotomy of the tendo Achillis. More motion and better position "when he tries." March, 1907.

CASE XII. A. C., age eight years. Operation Aug. 24, 1905. Paralytic equino-varus. Osteotomy of the scaphoid and os calcis, foot twisted and tenotomy of the tendo Achillis. More motion, good position and use of foot. March, 1907.

CASE XIII. G. D., age six years. Operation Aug. 28, 1905. Paralytic equino-varus. Transference of two slips of the flexor communis into the cuboid, tenotomy of the tendo Achillis. Result, good position and use of the foot; a little more motion and better position. March, 1907.

CASE XIV. M. B., age seven years. Operation

Sept. 7, 1905. Paralytic valgus. Transference of the peroneus longus and half of the tendo Achillis into the anterior part of the astragalus. Tenotomy of the tendo Achillis. Silk elongation. Immediate result satisfactory. Final result not known.

CASE XV. J. K. A., age seven years. Operation Sept. 26, 1905. Paralytic varus. Transference of outer half of the tendo Achillis into the cuboid with silk elongation. Operative result satisfactory. Ultimate result not known.

CASE XVI. H. A. R., age eighteen years. Operation, August, 1906. Infantile paralysis when ten years of age; worn apparatus for some time. Foot drop. The flexor longus transferred and silk strands inserted into the dorsum of the foot; shortening of the common extensor of the toe; tenotomy of the tendo Achillis. The wound healed, except a superficial granulation in some portions of the incision. The result three months after the operation was good, position of the foot and slight muscular power of flexion. Result, nine months later, good position and function and gain of movement in all directions in the foot. The foot drop.

CASE XVII. E. R., age five years. Operation June, 1906. Transference of a portion of the flexor communis digitorum by lengthened silk strands into the dorsum of the foot with two insertions, one on the inner and the other on the outer side. The immediate result was healing by first intention with good position. Ultimate result not yet determined.

CASE XVIII. R. W., age sixteen years. Operation August, 1906. Slip of flexor longus digitorum inserted by lengthened silk strands, both externally and internally, into the dorsum of the foot. Healing by granulation. Ultimate result six months later reported to be good.

CASE XIX. E. S., age three years. Operation April, 1907. Tendon transplantation of common flexor, lengthened by silk strands and inserted on the outer and inner side of the foot. Healing by first intention. Ultimate result not yet determined.

CASE XX. F. W., age ten. Operation September, 1906. Infantile paralysis requiring transfer of outer portion of common extensor of toes into cuboid by means of silk. Tenotomy of plantar fascia and tendo Achillis. A wedge was removed from the outer part of the astragalus. Good position of foot for use and function. March, 1907.

CASE XXI. E. W., age seven. Operation April, 1906. Infantile paralysis, requiring tenotomies and transfer of peroneus longus by means of silk strand to periosteum of scaphoid and shortening of paralyzed tibialis anticus and of extensor of toes. Result, March, 1907, better position of foot, some motion at point of transfer.

TENDINOUS FIXATION OF THE ANKLE JOINT FOR FRONT FOOT DROP.

Two cases of this procedure were reported in a previous paper. The operation being indicated where the paralysis is so extensive that no muscles offer sufficient strength for transference, the following three cases are mentioned, although recently performed, as suggesting some operative details. In the previous operations the silk strands were passed through a hole drilled in the tibia, and the tendons of the extensor communis were inserted and attached in a chiselled groove in the tibia. In one of these operations some sloughing followed and there was a delay in healing. A good ultimate result finally followed. In

the other cases prompt healing occurred without sloughing of the silk, and there was marked improvement in gait and entire correction of the toe drop. In the four following cases no bone attachment was attempted, the attachments being periosteal.

CASE XXII. C. F., age fifteen years. Operation June, 1906. Portions of the tibialis anticus and peronei tendons freed from muscular bellies and sutured to the periosteum of the tibia. Silk strands inserted sub-periosteally in the inner and outer side of the dorsum of the foot. The strands were then passed upwards subcutaneously to the incision on the upper portion of the leg, passing under the annular ligament, and secured into the periosteum surrounding the tibia. The tendo Achillis was divided. The wounds healed by first intention. Ultimate result, nine months later, improved position of the foot. Almost complete correction of front foot drop. Walks without apparatus. March, 1907.

CASE XXIII. M. S., age seven years. Operation February, 1907. Silk quilted through the periosteum about the tibia, three inches above the malleoli, passed subcutaneously under the annular ligament, and posterior insertion on the outer and inner side of the dorsum. Anterior tibial and common extensors attached three inches above the joint to the periosteum of the tibia. The wound healed by first intention. Ultimate result, foot held with entire absence of toe drop and with marked improvement in gait. May, 1907.

CASE XXIV. R. P., age eight years. Operation April, 1907. Complete paralysis of the extensor communis, peronei and tibialis anticus. The silk strands were quilted in the upper end into the periosteum of the tibia three inches above the ankle joint. The silk strands were then passed under the annular ligament and inserted on to the dorsum on the outer and inner side of the foot. A split portion of the tendo Achillis was removed and transferred, with silk elongation inserted into the outer and inner side of the dorsum of the foot. Strands from the tibialis posticus and tibialis anticus were dissected off three inches above the ankle joint and stitched by quilting stitch into the periosteum around the tibia. The tendo Achillis was divided. Immediate result, healing by first intention, with good foot fixation.

CASE XXV. M. S., age seven. Operation February, 1907. Silk strands passed through tibia and made fast to cuboid on one side and to scaphoid on the other, holding the foot at right angles. Result, foot held at right angles.

As the operation in the last two cases is recent, the ultimate result is at present undetermined, but there seems no reason to think that the usefulness of the limb will be less good than in the other cases previously reported.

TENDON TRANSFERENCE FROM THE HAMSTRINGS TO THE OS CALCIS BY ELONGATED SILK STRANDS.

CASE XXVI. E. D., age eight years. The following unusual operation, performed by Dr. Soutter, August, 1905, is of clinical interest, particularly from the fact that the procedure is an unusual one. The soleus, extensors and plantaris were paralyzed, the foot being held in the position of calcaneus. There was no flexor function of the toes, but there was good power in the hamstrings. A silk strand was quilted into the semimembranosus and extended downward and fastened to the os calcis.

The case was lost sight of for over a year, and when examined, the attachment of the silk in the os calcis was firm. The patient walked without the calcaneus

deformity, there was tendency to valgus and abduction of the front of the foot existed; but after four weeks of muscle training, the foot could be extended in the plantar flexion direction without flexion of the knee. The foot is held, at present, a year and a half later, in a good position, and some flexion in the toes is possible. May, 1907. Plantar flexion of the foot, due to the transfer, is strong enough for use.

FOOT AND KNEE.

CASE XXVII. H. M., (1) age eight years. Operation April, 1907. Transference of portions of the flexor communis, lengthened with silk strands inserted into the outside and inside of the dorsum of the foot. External hamstrings lengthened with silk inserted subperiosteally on either side of the patella, and continued and inserted into the tubercle of the tibia.

This operation was performed on the left leg. In the right foot, transference of portions of the flexor communis, with extension of silk strands and insertion on the outer and inner side of the dorsum of the foot. Healing by first intention throughout. Immediate result, good position and slight gain of motion. Ultimate result not yet determined.

CASE XXVIII. W. D., age twelve years. Operation January, 1907. Paralysis of the quadriceps extensor, tibialis anticus and peronei. Transference of outer hamstrings, with silk elongation to the patella and tibial tubercle. Transference of the flexor longus with silk strands inserted into the dorsum of the foot. Healing in part by first intention, and in part by skin granulation. The present result is good position, with slight muscular power in all directions. Under gymnastic exercises this is increasing.

CASE XXIX. M. H., age eight years. Operation August, 1906. Tendon transference of the flexor longus digitorum with silk insertion in the anterior portion of the foot; transference of the gracilis and a dissected portion of the iliotibial band serving as tendon of the tensor vaginae femoris into the patella by silk strands, and into the tubercle of the tibia. Healing by first intention, except the incision on the inner side of the hamstrings, which healed by granulation. Condition, April, 1907, excellent, with power of motion in extending the leg, and complete cure of toe drop, with slight motion in foot extension, abduction and adduction.

CASE XXX. R. R., age seven years. Operation July, 1906. Tenotomy of both tendines Achillis. Transference of a portion of the iliotibial band; gracilis and semimembranosus inserted into the patella. More motion, good position. April, 1907.

CASE XXXI. J., age twenty years. Operation Feb. 22, 1906. Paralysis left leg, extensor communis, and dorsal extensors of the foot. Outer hamstring was transferred forward with silk elongation, and inserted into the patella on both sides and on the ligamentum patellae. Transference of flexor communis with tenotomy of the tendo Achillis. Wounds healed by first intention, except two incisions, which healed by granulation. At present, April, 1907, absence of foot drop, and slight power in motions in all directions of the foot and at the knee.

CASE XXXII. S. M., age nine and one half. Operation Sept. 19, 1906. Semimembranosus transferred with silk strands to patella, and flexor longus digitorum put into cuboid. Tendo Achillis lengthened by tenotomy. Patient had complete paralysis of the other leg, and for four years previous to operation he crawled on his abdomen, using his hands for locomotion. March, 1907, his uncle reported that he was walking on the operated leg and crutches.

CASE XXXIII. H. W., age seven. Operation September, 1906. Infantile paralysis, requiring transfer of semimembranosus into the patella, by means of silk strands. Tendo Achillis split and one half carried forward to outer side to cuboid. Immediate result good. Ultimate result not known as yet.

SHOULDER.

The writers have already reported two cases of transference of a portion of the trapezius to the insertion of the deltoid for deltoid paralysis. They are able to add three cases of shoulder paralysis. In two the pectoralis major was cut down upon and a portion of the muscle freed and the same thing done with the trapezius; the separated muscular bands were united firmly. Giving an insertion of the elongated trapezius into the humerus.

CASE XXXIV. E. W., age five years. Operation July, 1906. Paralysis of the deltoid and triceps, with some power of the outer part of the biceps. The pectoralis muscles strong as was also the trapezius. Transference of portion of the trapezius forward with silk strands elongation into a portion of the tendon of the pectoralis major, which was freed from its muscular attachment, making for it an insertion into the humerus. The wound healed by first intention, and the ultimate result to date is restoration of the power of elevating the arm 45° above the height of the shoulder, with some anterior motion.

CASE XXXV. B., age eight years. Operation September, 1906. Paralysis of the right deltoid, but with some strength in the biceps. Transference of the trapezius with silk elongation insertion into the periosteum at the place of the deltoid insertion. Result, February, 1907, patient has improved power, can elevate the arm above the shoulder.

CASE XXXVI. D. R., age five years. Operation 1905. Paralysis of the deltoid, triceps and of biceps. Congenital dislocation of the shoulder subcoracoid. A portion of the trapezius separated from its insertion, one half of the pectoralis major tendon and some muscle fibers cut and separated from the rest of the muscle. This insertion of the pectoralis sutured to the freed fibers of the trapezius, forming an insertion for it in the humerus. One year later good use of arm in anterior motion and without tendency of shoulder to drop subcoracoid.

The after-treatment in these cases consisted of fixation of the arm by plaster of Paris handages in a position extended above the head, so as to raise as far as possible the inserted portion of the muscle. Plaster of Paris fixation was continued for six weeks. The arm was then placed in a less elevated position by a second plaster bandage, which was worn for a month. Later a right-angle wire arm support, keeping the arm and hand at right angles with the trunk, was worn, accompanied by beginning use, gymnastics, etc.

The result in these cases up to date corresponds with the result in two previous cases reported in the previous paper two years ago, the result of which has continued to be as satisfactory as when reported.

The details of the operative procedure in all these cases varied but slightly. They were all performed upon cases with slight or no resistant deformity, beyond tendon shortening, and

without great structural changes of tendon and muscular tissue. In all cases complete correction by force or tenotomy or both of the existing deformity was made before the muscle transference, with overcorrection in the resistant cases. The silk strands were inserted by quilting in the divided tendon, which was cut off as low down as possible. As small skin incisions were made as were feasible, but enough to expose adequately the muscle and tendon, and to enable the tendon to be transferred with as little of an angle of the transferred tendon as possible.

The transferred tendon or strand was covered by fascia specially sewed over it independent of the sewing of the skin incision. As a rule, no drain was placed in the wound, which was sewed up by catgut. The limb was placed in a moderately corrected position in a plaster bandage. As a rule, the wound was not examined for ten days or a fortnight. In most of the cases reported, the wound healed by first intention, either entirely or partially. In portions of the wounds there was superficial gaping. In none of the cases was there any evidence of sepsis, and no sloughing out of the tendons, although in the first cases operated upon by silk transference five years ago, sloughing of the silk occurred in five instances.

The periosteal insertion on the dorsum of the foot was made with care, a curved handled needle being used, taking a firm grip upon the periosteum. Bone drillings were not used.

The usual after-treatment in these cases was plaster fixation for two months, followed by apparatus which would prevent toe drop or abnormal strain, followed, when practicable, by muscle training, massage and gymnastics for several months.

It is difficult to determine in all cases when plaster bandage fixation should be omitted, and some functional activity of the muscle allowed. The matter is one of judgment and no fixed rule can be stated, as much depends upon the weight of the limb and the age of the patient. It may be considered as a general proposition that as soon as firm healing has been established, slight functional activity of the transferred muscles should be allowed in order to favor the formation of strong tissue.

In order to obtain the best ultimate result, the cases should be followed carefully, with a well-regulated treatment directed to the development of the weakened muscles; in many instances much gain can be effected in muscles previously considered beyond repair.

In cases of this class it is difficult to record and report the exact degree of improvement, as a slight amount of gain in a muscle apparently incapable of exerting functional power justifies in a child an expectation of greater gain under persistent care.

In the cases here reported all apparatus was removed at the end of either six or nine months following the operation, and in many cases increasing improvement followed the release from apparatus, with a gain of power from use.

The conclusions which the writers have drawn from their cases of tendon transference is in accord with the experience of many other surgeons, viz.:

That tendon transference is a procedure which offers with a minimum of risk a chance of great benefit. In none of the cases reported were the patients not benefited by operation, either by an improved position, or gain in functions. The immediate result in all was favorable, and the ultimate result in a number of cases surprisingly good.

A comparative study of the writers' cases previously treated by simple tendon transference without periosteal insertion and of tendon shortening of the relaxed tendons with the results gained by the careful employment of silk strand elongation of efficient muscles and periosteal insertion into selected and mechanically favorable points on the foot and tibia, demonstrates the superiority of the newer over the older method.

The strictest aseptic and antiseptic precautions are demanded. All of the operations herein mentioned were performed not only with all aseptic details as to the patient, instruments and dressings, but with the use of gloves and masks by the surgeon, his assistants and the assisting nurses.

The amount of benefit finally gained in function and correction of disability is in favorable cases so great as to justify an expectation of equal benefit in all cases. Even in extensive paralysis something can often be done to improve the condition.

THE SEASHORE TREATMENT OF THE TUBERCULAR ARTHRITIS OF CHILDREN.

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TUBERCULAR arthritis is essentially a disease of childhood, 85% of the patients who have applied at the Rhode Island Hospital for treatment for this condition having been under fifteen years of age. The course of the disease is chronic, its duration, for years, attended with the formation of abscesses and discharging sinuses and usually terminating fatally from tubercular meningitis, tubercular peritonitis, or some other intercurrent disease as the immediate cause of death.

The treatment of these cases has consisted of immobilization of the affected joints by braces or plaster casts and of various surgical operations for the removal of pus and diseased bone, or for the correction of deformities. Although this treatment has been efficient in diminishing the deformities of those patients who have survived, it has had little effect in lessening the suffering and fatality of the disease.

It is urged, with some appearance of reason, that an attempt to save the lives of patients with tubercular joint disease is opposed to the law of the survival of the fittest, and that these children should be allowed to die rather than to grow up deformed, to pass on their tubercular taint to succeeding generations. Opposed to this argument, is the fact that these crippled children suffer tremendously, not only the acute pain of burrowing abscesses and of muscular spasm, but also

the constant discomfort from restraint of motion. Whatever our ideas may be as to the value of their lives, we must unite in believing that any time spent in freeing their distorted little bodies from suffering is time well spent.

Following the lead of the Children's Island Sanitarium at Marblehead and the Sea Breeze Sanitarium at Coney Island, the Rhode Island Hospital, in the summer of 1906, first opened the ward for the seashore treatment of the tubercular arthritis of children. The entire expense of the work was defrayed by the late James A. Garland, whose death cast a shadow over the last weeks of the summer's work. The Garland ward was located thirty-five miles from the city of Providence on Conanicut Island, in Narragansett Bay, where an old hotel, with good bathing facilities, was converted into a temporary hospital. This institution was open from the middle of July to the first of October.

There were 32 patients, 11 of whom came from the wards of the hospital in Providence. A great deal of care was taken in the selection of the patients. They were children under sixteen years of age, who were afflicted with tubercular arthritis and belonged to the following classes:

First, cases of extreme severity.

Second, patients living amid improper surroundings with insufficient nourishment.

Third, cases steadily failing from any cause. There were 20 boys and 12 girls. The average age was nine and one quarter years. The youngest was fourteen months old. In 14 cases, the hip was affected; in 9, the spine; in 7, the ankle; in 1, the knee and in 1, the shoulder. The duration of the disease had been from six months to eleven years. The average duration had been three and one-half years. Every patient had at some time been in the hospital for a period varying from one to thirty months. Twelve children had a total of 25 suppurating sinuses.

Realizing the influence of bad surroundings and improper food in the development of the disease, the treatment was largely hygienic, drugs being used only in an occasional emergency and no operating being done at the summer branch. Fresh air day and night, sea bathing, an abundance of nutritious food and freedom from restraint, both mental and physical, formed the basis of the treatment.

Seashore treatment of tubercular arthritis. The simple extension straps employed.

From sunrise to sunset, the children lived out of doors and the windows of their sleeping rooms were never closed. All the patients bathed in the salt water, as many as possible bathing every