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21.

SUTURING THE TENDO ACHILLIS IN THE CORRECTION OF DEFORMITIES OF THE FEET.¹

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EXPERIENCE has shown that in most of the deformities of the feet that require operative procedures for their correction the tendo Achillis demands section, and not infrequently the lengthening or shortening of that structure only is required.

It is clearly apparent that all remedial measures, to be ultimately and progressively efficient, must have for their object not alone removing the appearance of the deformity, by lengthening or shortening of tendons, but it is equally essential that the resulting strength of the tendon must be equal to the demands to be placed upon it.

The tendo Achillis communicates to the heel the power required to enable the arch of the foot to maintain the weight of about three times as many pounds as it exerts pounds of force. The leverage of the foot in walking is that of the second order of levers,—that is, where the weight is placed between the power and fulcrum, the power being applied to the posterior end of the os calcis, the fulcrum being the distal extremities of the metatarsal bones, while the weight is imposed upon the astragalus.

Careful measurements of over a hundred approximately normal feet have resulted in showing that the average comparative distance from the end of the os calcis to the centre of the internal malleolus, and from that point to the end of the distal extremity of the metatarsal bone of the big toe, was as 1 to 3.

This adverse position of the weight in its relation to the power and fulcrum necessitates the use of a greater power moving through a small distance to lift weight equal to one-third of the power through a proportionally greater distance.

The powerful action of the gastrocnemius and soleus muscles would be less confusing if it could be disassociated from its attachment to the weight it is to lift. Let it therefore be assumed that the upper end or insertion of this muscle is made fast to some immovable body, and then its action in lifting the whole body will be apparent. A force of one unit applied to the

¹ Read before the Medical Society of the State of Pennsylvania, May 17, 1893.

power end of this lever would raise a weight of three units if the foot was reversed,—that is, if the tendo Achillis was attached to the tarso-metatarsal joints. This is the most common application of the second order of levers, because it enables a small number of pounds of force to move a larger number of pounds of weight, in proportion to its distance from the power and its approximation to the fulcrum. The advantage of less power is, however, at the expense of the arc of movement of the power end of the lever. Economy of space, even at the expenditure of increased power, often becomes necessary in the arts, and is well exemplified in the human foot.

This expenditure of power, equal to three times the weight to be moved, requires that the means of communicating the power should be equal to the maximum strain that might be required to sustain additional weights, and thus we perceive that the tendo Achillis is the most important and, at the same time, the strongest and broadest tendon in the body.

The great importance of the tendo Achillis in locomotion, as indicated by its breadth and strength, as well as by its mechanical function, demands that its strength and general utility, after operation, should be increased rather than lessened, and that the correction of the external appearance of a deformity should be secondary to a full re-establishment of the mechanical functions of the part.

The subcutaneous operation for lengthening the tendo Achillis, while it has had a brilliant career in assisting in the correction of deformities of the feet that were, previous to its adoption, corrected in part only, did not always fully meet the full requirements.

The gap between the divided ends of the tendons were filled by ultimate fibrous union, which yielded when there was full contractile power in the gastrocnemius and soleus muscles, and only failed to yield when those muscles were largely inactive from previous disuse.

The disturbance of the repose essential to a perfectly solid union was clearly shown upon a patient upon whom I spliced the tendo Achillis under the local anæsthesia of cocaine; the contractions of the muscles increased the separation of the ends a full inch, making the gap two and a half inches, and this constant or voluntary contraction must make the uniting band attenuated.

It is impossible to disassociate the shrunken, atrophied, and often useless calf with the possibility of its being assisted in its retrograde by the weakened condition of the tendo Achillis divided in the often hap-hazard subcutaneous method.

If there was, prior to division of the tendon, an atrophy or enfeebled calf, analogy would indicate that favorable conditions would promote its growth and development until a full or approximately full usefulness could be obtained.

That the new band of union uniting the tendon is capable of stretching has become well established in cases that have required open section at some subsequent time. Several illustrations of this have come under my notice,

in one of which the original separation of one inch had increased to two and one-fourth inches. The fibrous connecting-band was extremely thin, and so firmly bound to all the surrounding structures that a most careful dissection was required to lift it from its bed. It was found to be attenuated to such an extent that it was found impossible to use it in the effort to shorten the tendon, and recourse was had to a method of splicing, by taking parts of the original tendon.

In a large number of relapsed cases that have required subsequent division of the tendo Achillis, it has been found that it was practically impossible to find a tendon. The extensive amount of elongation so often seen after transverse fracture of the patella is still further evidence in the same direction.

The inaccuracy and, therefore, uncertainty of the results to be obtained by simple subcutaneous division made the reception of methods of accurately elongating and shortening tendons, by splicing, a boon that has been rapidly seized by progressive operators. Although asepsis prepared the way, surgeons were not prepared to take the advanced step of suturing tendons until time had elapsed to prove the benefits to be derived from the simple section through an open wound.

I desire here to acknowledge my personal indebtedness to Dr. W. W. Keen, of Philadelphia, from whom I first learned, on March 4, 1891, of the practical application of accurately lengthening tendons. On the above date Dr. Keen read before the College of Physicians of Philadelphia a paper entitled "A New Method of Tenotomy, by which the Tendons are Lengthened to a Definite Extent, instead of the present Hap-hazard Method."

In the opening paragraph of this paper Dr. Keen very gracefully attributes the suggestion of the method to the originator, as follows: "I owe the suggestion which, I believe, I carried out for the first time anywhere, to the fertile mind of my friend Dr. S. Weir Mitchell, who has adorned every department of medicine which he has touched."

The patient, with post-hemiplegic contracture of the flexors of the fingers, was operated upon by Dr. Keen on November 29, 1890. The method of procedure was then described. "Each tendon was first split in the middle, one and one-quarter inches, and then, at the two ends of this incision, section of the opposite halves of the tendon was made. The two cut ends were then slid past each other and sewed together for a distance of half an inch, making three-quarters of an inch of lengthening." On December 19, twenty days after the operation, it is recorded, "She went home to-day. Her hand is in much better condition, though she cannot yet flex the fingers to any extent. The tendons are not torn loose, inasmuch as extension faradization flexes the fingers."

Thus the new method suggested by Dr. S. Weir Mitchell, and resorted to by Dr. W. W. Keen, was first published, and by many was referred to as the Keen method.

In the *American Lancet* for February, 1892, I published a clinical lecture entitled "Tenotomy by Open Incision for Talipes Equinus," in which I gave the credit of originating the operation to Dr. W. W. Keen, and I desire at this time to correct the published statement then made and since repeated.

By one of those curious coincidences of which there are so many illustrations, the desire for better methods has induced men in different parts of the world to arrive at precisely the same ends without the slightest knowledge of the other's work.

In the *London Lancet* for July 18, 1891, there is published the second of a series of lectures delivered at the Royal College of Surgeons on June 10, 1891, or three months after Dr. Keen read his paper before the College of Physicians, by William Anderson, F.R.C.S., entitled "Contractions of the Fingers and Toes: their Varieties, Pathology, and Treatment."

In this lecture he describes exactly the same operation on a patient in whom "the third, fourth, and fifth fingers of the right hand were found to be flexed at the metacarpo-phalangeal and inter-phalangeal joints." On October 18, 1889 (a little more than thirteen months prior to Dr. Keen's operation), "the tendon of this muscle going to the ring-finger was then isolated, transfixed by a fine tenotomy-knife, and split longitudinally for a distance of two inches. At each end of the fissure so made the tendon was divided in such a manner as to leave one-half the split portion attached to the proximal, the other to the distal, end of the tendon. When the fingers were fully straightened the ends of the divided tendons still overlapped each other to the extent of about one-third of an inch. The overlapping portions of each tendon were then carefully sewed together by catgut sutures, etc. Two months later the condition had much improved, and the voluntary flexion, although still weak, was altogether complete as to range. All the tendons had evidently united firmly."

If the date of publication were taken as a basis the credit of originating this operation would, of course, be given to Dr. S. Weir Mitchell, and of performance to Dr. W. W. Keen, but although the lectures of Mr. Anderson were not published until July 18, or about four and a half months after Dr. Keen read his paper, the dates of the respective operations must clearly establish the priority. Mr. Anderson performed his first operation on October 18, 1889, while Dr. Keen's operation was performed on November 29, 1890, one year and something over a month later.

If there could be any question remaining in the mind of any one as to priority of invention and performance, the correspondence between Mr. William Anderson and Dr. W. W. Keen, as published in the *Lancet*, November 21, 1891, page 1195, will make the matter clear.

"LENGTHENING TENDONS IN DEFORMITIES OF THE HAND.

"TO THE EDITORS OF THE LANCET:

"SIRS,—In my second Hunterian lecture at the Royal College of Surgeons, delivered on June 10 last, and published in the *Lancet* of July 18,

I described a new method of lengthening tendons, and recorded a case of contraction of the fingers in which it had been successfully employed by me at St. Thomas's Hospital, in October, 1889. A few weeks ago Professor Keen, of Philadelphia, with whom I had the pleasure of a correspondence on the subject of hand deformities, favored me with a reprint of a paper read on March 4 last before the Philadelphia College of Physicians, relating to an identical operation undertaken by himself in November, 1890, at the suggestion of Dr. Weir Mitchell. The paper was entitled 'A New Method of Tenotomy, by which the Tendons are Lengthened to a Definite Extent, instead of by the present Hap-hazard Method.' Professor Keen, of course, had then no reason to believe that his case was not the first of the kind; but after receiving a letter from me pointing out the date of my operation, he has with the greatest promptitude and courtesy sent me the following reply, which I beg you will do me the kindness to insert in order to dispose of any question that might arise hereafter.

"I am, sirs, yours obediently,

"WILLIAM ANDERSON.

"HARLEY STREET, W., November 14, 1891.

"COPY OF LETTER.

"1729 CHESTNUT STREET, PHILADELPHIA, October 13, 1891.

"MY DEAR MR. ANDERSON,—I am greatly pleased to receive your letter of September 30. I feel that I deserve very little credit myself, because the idea was purely original with my friend Dr. Mitchell, who suggested it to me, as I stated in my paper. Any credit, therefore, really belongs to him. At the same time I will freely admit that priority both as to idea and performance belongs to you. I had overlooked the fact that your operation was done in 1889. If you will kindly write a little note to the *Lancet* calling attention to the fact, it will entirely meet with my approval.

"Very truly yours,

"W. W. KEEN."

In similar instances of coincidental invention the names of both parties have been used where it was deemed desirable to call the operation after the originators. In this instance I have lately been in the habit of alluding to this operation either as the Anderson-Keen method, or by such descriptive title as "Longitudinal Tenotomy and Suturing at a Definite Point," but Dr. Keen's letter published in the *Lancet* disclaims his right and accords it to Anderson, and, therefore, I believe that hereafter the operation should be known as Anderson's method.

Quite recently, March 25, 1893, the *Centralblatt für Chirurgie* published an article by Dr. Trnka, entitled "A Contribution to the Technique of Suturing Tendons," in which the author speaks of methods which he employed for the first time in 1887. As his method is entirely different

from the previously described method, and as it was published for the first time in March 25, 1893, it could not have influenced the production of the method first described in this paper, nor in my mind detract from the originality of either of those operators already referred to.

Trnka utilizes a lateral section of the upper portion of the divided tendon, which he turns down and stitches securely to the lower portion, or else he unites the divided ends by strands of catgut securely sutured to each of the divided ends of the tendon.

While the two methods of accurately operating upon tendons were devised for the purpose of elongation, that which is most frequently required, I was impressed with the applicability of the longitudinal splicing method of Anderson to the shortening of tendons.

In the discussion which followed the reading of Dr. Keen's paper on March 4, 1891, I spoke of its applicability to shortening tendons. On June 10, 1891, I resorted to the method in a case of paralytic talipes calcaneus, and have since that had occasion to employ it four times, although there are no published records. In my doubt as to whether this method had been tried to shorten tendons, I wrote to Mr. William Anderson, from whose letter of April 4, 1893, I quote: "The application (of the method under consideration) to tendon shortening is certainly yours. I expect to receive a suitable case for testing it in the course of a few days, and should I not be disappointed I will let you know the result."

The "American Text-Book of Surgery," edition of 1893, page 324, says, "Lately Anderson and several other surgeons have simultaneously proposed to lengthen the tendons by a definite amount in cases of contracture," and on page 323 is given an illustration as though reproduced from Dr. Keen's original paper of March 4, 1891.

The other surgeons above referred to embrace the methods already described, and in addition those in which it was attempted to obtain the same result by recourse to subcutaneous methods. It is clearly apparent that the essential feature of the methods described is the suturing together of the splice so that the elongation or shortening should be of a definite amount. In the subcutaneous methods there has been no attempt, as far as I know, to suture tendons, and shortening cannot be accomplished subcutaneously.