

(FROM THE ORTHOPÆDIC HOSPITAL IN AARHUS
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TENDON TRANSPLANTATION FOR THE REPAIR OF OPPONENS PARALYSIS OF THE THUMB

*Results from Operations after the Methods of
Ney and Silfverskiöld.*

BY

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During the last quarter of a century a large amount of work has been done to find a satisfactory method for operative reconstruction of the opposition of the thumb after paralysis, chiefly following anterior poliomyelitis, which comparatively often involves an isolated paralysis of the m. opponens. The problem has been dealt with at various conferences, for instance at the 10th Congress of the Northern Orthopædic Association in Helsingfors in 1928 and at the following 11th Congress in Oslo 1929. At the German Orthopædic Congress of 1930 in Heidelberg, *Steindler* discussed the various methods suggested for the surgical treatment of this condition.

Operative reconstruction has been proposed on the basis of two widely different principles. One is an arthrodesis in the metacarpophalangeal joint of the thumb (as suggested by *Spitzzy*) intending to place the thumb in the best possible position for work, *i.e.*, in middle flexion, opposition, and rotation. Actually this procedure, however, compromises the most important function of the thumb, *viz.* its great mobility, and transforms it into a kind of prosthesis. The other principle, plastic repair of the m. opponens, aims at the reverse end, endeavouring to re-activate the opposition of the thumb as far as possible.

A search of the literature reveals that three different methods have been suggested for this purpose: (1) *tendon translocation* after the method of *v. Baeyer*, (2) *tendon transposition* after the method of *Howell*, and finally, by far the most common form (3) *tendon transplantation* which has been suggested in a number of different modifications, (first of all *Nicolaysen* and *Huber* described their modification at the same time, but without being aware of each other).

The first of these three methods only changes the position of the muscle without affecting its origin or insertion. *v. Baeyer*, therefore, calls it the most gentle of all methods and emphasizes as its greatest advantage the fact that no suture of the tendon is required.

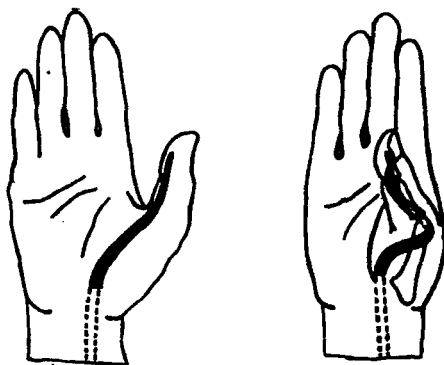


Fig. 1.

Scheme of tendon translocation by the method of *v. Baeyer*.
(*Zeltschr. f. orthop. Chir.* 56, 552, 1932).

He employs the tendon of *m. flexor pollicis longus* which is exposed in its entire course in the hand from the *ligamentum carpi transversum* to its insertion on the distal phalanx. The thumb is then by strong flexion and opposition passed under the flexor tendon which thus comes to form a kind of loop around the 1st metacarpus, extending from the place of insertion around the ulnar border of the thumb, across its dorsal surface, and then around the radial border, again to the volar aspect into the former position of the tendon (see Fig. 1). In this manner the tendon takes over the function of *opponens* and *flexor* at the same time. The circular incision around the base of the thumb is, however, objectionable. It is said sometimes to be followed by necrosis of the skin.

The next method is very like the first. It also employs the tendon of m. flexor pollicis longus. Apart from the incision, the only difference between the two methods is that *Howell's* method necessitates division and suture of the tendon. *Howell* reports a satisfactory result in the 8-9 cases he has used the method.

The tendon of the m. flexor pollicis longus is cut immediately proximal to the ligamentum carpi transversum. The distal end of the tendon is passed subcutaneously like a loop around the 1st metacarpus, and thus given exactly the same course as in *v. Baeyer's* method. Thereupon the two cut ends are re-united. As in the first method, the effect of this method is an opposition as well as flexion.

The method of choice is, however, tendon transplantation, i.e., the entire tendon or part of it is moved to a new insertion. It is not saying too much that nearly all the muscles of the hand and forearm have been tried as transplantation material for plastic repair of the opponens pollicis.

The most common usage is transplantation of the tendon of m. palmaris longus either direct, to the 1st metacarpus (*Camitz*) or to m. extensor pollicis brevis (*Ney, Nilsonne*). Moreover, transplantation of m. flexor dig. sublimis III (*Krukenberg*) or m. flexor dig. sublimis IV (*Roeren, Kochs*) passing the tendon subcutaneously through the palm to the distal end of the 1st metacarpus where it is fixed on the radial side. Sometimes this procedure is supplemented by fixation of the tendon in the ulnar part of the hand, e.g., on a level with the pisiform bone, in a kind of vinculum, in order to secure a constant direction of the tendon (*Bunnel*). Less commonly, use is made of m. extensor minimi digiti (*Cook, Weil*), m. abductor dig. V (*Huber, Nicolaysen*), and m. extensor dig. comm. III (*Jahn*).

Finally, the tendon of the m. flexor pollicis longus has proved to be a most suitable material for transplantation. *Steindler* splits the tendon and passes its radial half to the dorso-radial side of the distal end of the 1st metacarpus. In 1930 he had performed this operation in 20 instances. Of these 20 cases the permanent result had been good in 16, fair in 3, and poor in 1. *Silfverskiöld* has introduced a modification of

Steindler's method, moving the entire tendon to its new insertion to the radial and dorsal side of the distal end of the metacarpal bone. The flexion of the distal phalanx of the thumb is hereby lost, but that is not of major importance. According to *Silfverskiöld*, the opposition movement after this operation is carried out quickly, quite correctly, and with good power.

The method of using the tendon of the m. flexor poll. longus for the transplantation possesses the advantage that it is a rather powerful muscle which often is not involved in poliomyelitis paralysing the thenar muscles. The transplanted tendon is, furthermore, given exactly the same direction as the m. opponens, and it becomes embedded comparatively deeply. The result is a correct traction on the thumb, unlike a number of other methods in which the transplant is placed somewhat superficially, passing subcutaneously through the vola and arriving at right angles on the metacarpal bone, and therefore sooner produces an adduction of the thumb than opposition (*Bentzon*).

The movement of opposition consists of a combined opposition, flexion, and adduction to which is added the extremely important factor of rotation on the longitudinal axis of the thumb. This rotation is essential for the grasp between the thumb and the other fingers, when the ball of the thumb should face the ball of the opposite finger. This movement of rotation is entirely due to the m. opponens (*Grünkorn*), and the same rotation of the thumb is therefore obtainable by the transplanted tendon of the m. flexor poll. longus. On autopsy preparations *Silfverskiöld* has performed his method of transplantation and demonstrated that by pulling the tendon of m. flexor poll. longus he could make the thumb perform a completely regular movement of opposition, facing the respective fingers in turn.

It has been objected that the method is too radical, depriving the thumb of the power of flexion in the distal phalanx, and it has been said that the primary condition of any intervention is that it must do no harm. Therefore, *Nilsson*, who makes use of the m. palmaris longus by the method of *Ney*, points out an advantage of this method, i.e., that the muscle is of no im-

portance to the hand, and that it would therefore not be missed, should the intervention prove a failure.

In reply one may set forth several arguments. In the first place it is of essential importance that the muscle used for the transplantation be a powerful one like *m. flexor poll. longus* instead of *m. palmaris longus* which is comparatively weak. This is a fact which becomes strikingly apparent by a comparison between the results of the two methods. In another paper, *Nilssonne* himself admits that the power of opposition following tendon transplantation after the method of Ney, performed by him in 12 cases, does not become very great, and not at all sufficient for coarse function. *W. Mercer* has had the same experience. In his book on "Orthopædic Surgery" he states that he has abandoned the use of *m. palmaris longus*, because the muscle is too weak. Instead he employs the radial half of the tendon of *m. flexor carpi ulnaris*. Moreover, patients who have been submitted to *Silfverskiöld's* operation do not miss the lost flexion in the distal phalanx of the thumb. A seamstress stated that she only thought of it, when she was to undo stitches. The ideal solution would be the establishment of a plastic repair acting as opponens as well as flexor. Splitting the *m. flexor poll. longus* after the method of *Steindler* is not the way out, as both movements become too weak. As mentioned above, this combined effect is said to result from translocation as well as transposition of the tendon of the *m. flexor poll. longus*. We have had no experience with these two methods.

During the period from 1936-46 the Orthopædic Hospital in Aarhus has admitted a total of 821 patients under a diagnosis of sequels of anterior poliomyelitis. Nineteen tendon transplantations for opponens paralysis of the thumb were performed on a total of 18 patients, as one patient was submitted to a bilateral activation of the opponens. No statistics have been made of the number of patients with opponens paralysis not submitted to operation (either because of unsatisfactory material for the transplantation or on account of refusal to be operated on). Six tendon transplantations were made after the method of Ney and 12 after the method of *Silfverskiöld*. An

atypical tendon transplantation was performed in one case, *i.e.*, the *m. flexor carpi radialis* was transplanted to the *m. extensor poll. longus* with the intention of activating the extension of the thumb at the same time. As far as the opposition was concerned, the result was poor, but the grasp of the hand has been found to be tolerable upon several after-examinations.

The sex incidence of the 18 patients submitted to these operations is exactly equal, 9 males and 9 females, of course due to pure chance. The age of the patients at the time of the operation ranges from 5 to 26 years. As a general rule plastic repair of an *opponens* paralysis is not indicated until the age of 5, so that the result obtainable by the operation is available, when the child begins to attend school.

The period elapsing between the onset of the disease and the intervention is, however, a matter of appreciably greater importance than the age of the patients at operation. The shorter the interval, the better have the operative results proved to be. The paralysis of the thenar muscles is gradually followed by a dorsal subluxation in the metacarpophalangeal joint of the thumb with a simultaneous external rotation of the latter. This, in connection with the atrophy of the thenar, lends the hand a quite characteristic aspect, the so-called "ape hand". When it has once been established, this subluxation has proved to be very difficult to correct by plastic repair, even with as powerful a muscle as the *m. flexor poll. longus*. This position of the thumb in itself prevents a correct opposition. *Nilsonne* has therefore suggested that one might supplement the tendon transplantation with an arthrodesis in the metacarpophalangeal joint of the thumb in cases of marked subluxation. This procedure improves the result of the operation considerably. As stated above, one cannot, however, directly accept an arthrodesis in the extremely mobile metacarpophalangeal joint of the thumb. The important thing is to prevent the subluxation by operating earlier (or by applying a temporary correcting splint). On the other hand, one is apt to defer the operation until a spontaneous subsidence of the paresis has been awaited for a suitable period. The time of the operation is, therefore, mainly

a matter of discretion. As a rule the interval is one year. In this department we have, however, several times performed the tendon transplantation earlier on patients who, though severely affected, had not yet exhibited subluxation of the thumb, and our results have been excellent.

The extent of the paralysis is, of course, the most important factor in the result of the plastic repair. Reviewing the 19 tendon transplantations constituting this material, the writer has grouped the cases into mild, moderate, and severe: (1) mild if the paralysis of the opponens has been the only remaining paralysis (4 cases, 2 operated on after the method of *Ney*, 2 after the method of *Silfverskiöld*), (2) moderate if it was accompanied by paresis of several other muscles in addition to a slight atrophy, but still exhibiting the lacking opposition as the most essential trouble (9 cases, 3 operated on after the method of *Ney*, 5 after the method of *Silfverskiöld*, and 1 with an atypical tendon transplantation), and finally (3) severe if it is a question of extensive paralyses with marked muscular atrophy and shortening of the upper extremity, exhibiting the lacking opposition as only one trouble among several others (6 cases, 1 operated upon after the method of *Ney*, 5 after the method of *Silfverskiöld*).

In order to avoid any misunderstanding, the writer wants to point out that this grouping only refers to the pareses of the upper extremities. A case listed as mild because the paresis of the opponens pollicis was the only one that remained, may of course have been severe when regard is paid to extensive pareses of the lower extremities, if any.

The technique of the operation has been the one described by the two authors, except in our most recent cases in which the one large incision used by *Silfverskiöld* has been substituted by by 3 small incisions, (1) on the volar aspect of the thumb on a level with the insertion of the tendon on the distal phalanx, (2) on the distal border of the ligamentum carpi transversum, slightly to the ulnar side of the thenar, and (3) on the dorsal aspect of the thumb at the 1st interphalangeal joint corresponding to the new insertion of the tendon (see Fig. 2).



Fig. 2.

The three incisions used by us in operation by the method of *Silfverskiöld*.

In our opinion this method has secured better cosmetic results, and it affords a better survey, when the tendon is sutured to its new site of insertion. *Silfverskiöld*'s incision sometimes makes it rather difficult to place the sutures as far to the dorsal side as desirable when fixing the tendon.

Twelve of the 18 patients have been followed up for a period ranging from 6 months to 4 years after the operation, in one case even 7 years after the operation. Four cases have been operated upon so recently (after October 1945) that an after-examination has not been made, and 2 patients failed to respond to the request to appear at the Hospital for after-examination. In these 6 cases the operative result is put down as it was found to be when they left the hospital, *i.e.*, probably not as good as the ultimate result.

The classification of the operative results in such cases is of course to a great extent a matter of discretion, particularly when the patients have been after-examined by different doctors. Nearly all these patients, however, appear at our ambulatory at regular intervals, for control or changing of bandages. Therefore, we have had occasion to examine them repeatedly and compare the opinion of the various examiners. Moreover, the same examiner (Dr. *Bentzon*) has seen nearly all the patients

at some time or other and noted down his judgment. Thus, a certain guarantee may be said to exist of a uniform judgment.

The examiner has a few objective features to go by: The power of the opposition movement indicated by the grasping and lifting capacity (a flat plate with weights attached) and moreover the position of the thumb during the movement of opposition; it is of particular importance to ascertain the essential rotation of the thumb on its own axis, so that one pulpa faces the other in the act of grasping. As a general rule we have photographed all the cases after the operation in order to obtain an objective judgment of the result as far as possible.

The writer has grouped the results into 4 grades: poor, fairly poor, fairly good, and good. This grouping, of course, is also based on a subjective estimation, not so easily explained objectively. Under the heading of "poor" the writer has classed cases unchanged after the operation which, therefore, must be called failures. A result is called good only if the opposition movement in itself and its power are satisfactory, and if the thumb has obtained the correct rotation during the movement of opposition.

The operative results appear from Table 1 which presents all the cases. It is evident that the results are appreciably better after Silfverskiöld's method than Ney's, only 1 of 6 cases operated upon after the latter method being classed as unquestionably good. The remaining 5 are far from having gained the desirable power of the motion, and the rotation in the opposition, in particular, leaves much to be desired. The latter is most distinctly illustrated in Fig. 3 showing the operative result in Case 3. The patient is a seamstress, aged 26, who had had poliomyelitis at the age of 2 and still had extensive paralyses of the lower limbs. The left upper limb, however, only exhibited the paresis of the *m. opponens*, so in this respect the case must be grouped with the mild ones. It is distinctly apparent from the figures that it is the ulnar border of the thumb which meets the ball of the opposite finger. By way of comparison, Fig. 4 represents an excellent result of tendon transplantation after the method of Silfverskiöld obtained in a case who had several

TABLE 1

Case No.	Case rec.	Onset of poliomyelitis	Grade of paralysis (cf. the text)	Operative method	Operative result
1	B 3117	9 years ago	moderate	Ney	fairly poor
2	B 3234	21 " "	severe	Ney	fairly poor
3	B 5446	24 " "	mild	Ney	fairly good (see Fig. 3)
4	B 6111	1½ " "	moderate	Ney	fairly good
5	B 6641	1 year "	moderate	atypical tendon trans- pl., m. flex. carpi rad. ext. poll. long	poor
6	B 7574	4 years "	mild	Ney	fairly good
7	B 14669	3 " "	severe	Silfverskiöld	fairly poor
8	B 14669	3 " "	"	"	" "
9	B 15528	4 months ago	moderate	Ney	fairly good
10	B 16254	1½ years ago	mild	Silfverskiöld	good
11	B 16975	1½ " "	moderate	Silfverskiöld	good
12	B 17290	5 " "	severe	Silfverskiöld	fairly poor
13	B 19263	4 " "	moderate	Silfverskiöld	fairly good
14	B 23418	6 months ago	severe	Silfverskiöld	good
15	B 24762	6 " "	moderate	Silfverskiöld	good (see Fig. 4)
16	B 15199	21 years ago	severe	Silfverskiöld	fairly poor
17	B 15156	4 " "	mild	Silfverskiöld	good
18	B 26554	8 " "	moderate	Silfverskiöld	fairly good
19	B 27190	1 year "	moderate	Silfverskiöld	good

other pareses apart from that of the m. opponens, among others, a slight paresis of the m. flexor poll. longus. As a matter of fact the operation resulted in a completely natural opposition of the thumb. Silfverskiöld's method does not, however, always give good results. In Cases 7, 8, and 12 the m. flexor poll. longus was too weak. In Case 16 it was rather good, but a marked subluxation in the metacarpophalangeal joint of the thumb prevented a proper reconstruction of the movement of opposition.

On the whole, better results are obtainable with Silfverskiöld's operation than Ney's, because the m. flexor poll. longus

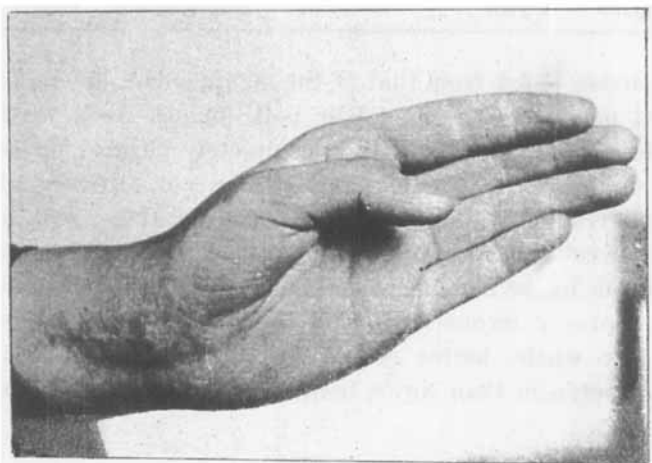
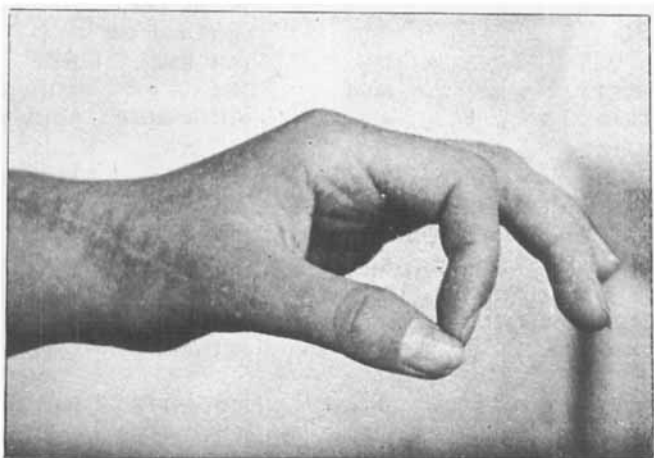
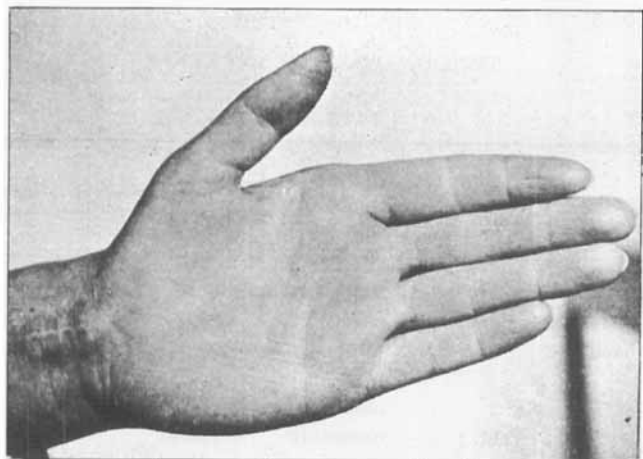


Fig. 3.
Case No. 3, operated after the method of *Ney*.

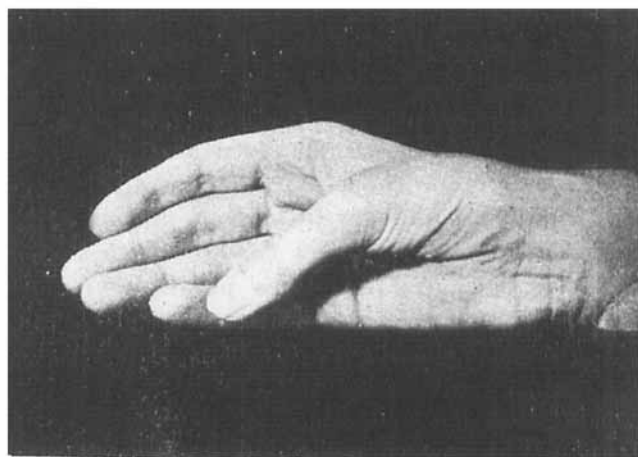
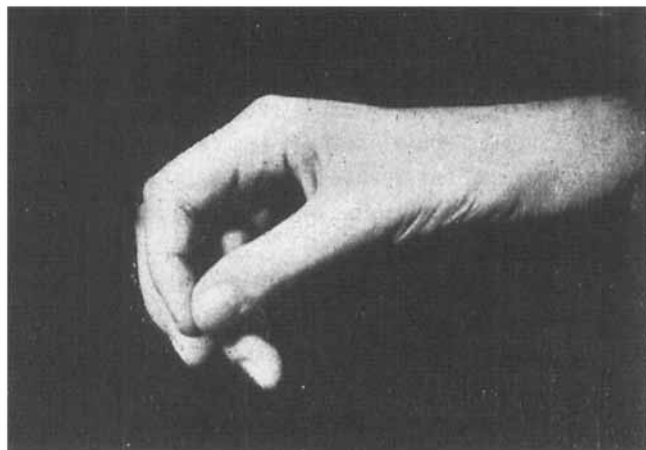
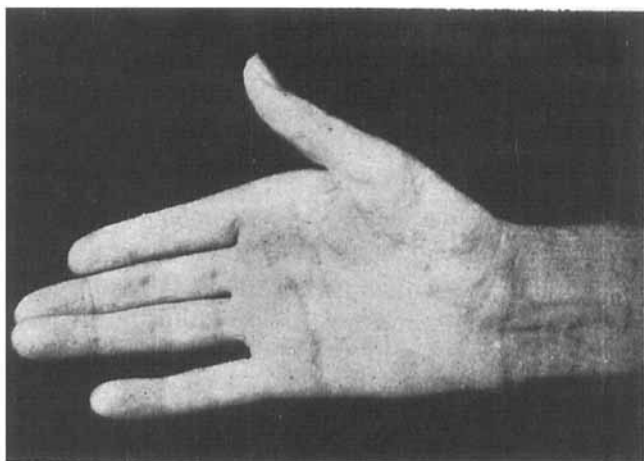


Fig. 4.
Case No. 15, operated after the method of *Silfrerskiöld*.

is a powerful muscle, and the course and position of the transplanted tendon are more suitable. But this muscle may, of course, be more or less paretic and thus unfit for the purpose. Whichever method one chooses, it is important to perform the tendon transplantation at an early stage in order to avoid a dorsal subluxation in the metacarpophalangeal joint of the thumb, as it is bound to prevent the establishment of a proper opposition.

SUMMARY

A number of different methods have been advocated for the operative reconstruction of the opposition of the thumb following paralysis of the latter, chiefly after anterior poliomyelitis. The writer rejects arthrodesis in the metacarpophalangeal joint (suggested by *Spitzzy*), because it reduces the thumb to a mere prosthesis. Plastic repair of the paralysis, on the other hand, often leads to excellent results, apparently most favourable, if the m. flexor pollicis longus is used for the tendon transplantation.

The writer reports 19 tendon transplantations performed to activate the opposition of the thumb, 6 after the method of *Ney*, 12 after the method of *Silfverskiöld*, and 1 with an atypical tendon transplantation. The best results were obtained with the method of *Silfverskiöld* which makes possible a reconstruction of the essential factor of rotation in the opposition movement of the thumb, because of the deep position as well as the favourable direction of the tendon after the transplantation.

RÉSUMÉ

Différentes méthodes sont indiquées de la reconstruction opérative de la fonction de l'opposant du pouce après la paralysie de celui-ci, qui se produit souvent après la poliomyélite. Tandis que, selon l'auteur, il faut écarter l'arthrodèse de l'articulation métacarpo-phalangienne I (indiquée par *Spitzzy*), puisqu'elle réduit le pouce à une sorte de prothèse, on obtient souvent par la ténoplastie des résultats excellents.

Les meilleurs résultats semblent être obtenus par l'emploi de m. flexor pollicis longus pour la plastique de l'opposant, ce qui est probablement dû au fait que ce muscle est suffisamment fort.

Sur la base de 19 cas de ténoplastie pratiqués pour récupérer la fonction de l'opposant du pouce, dont 6 a. m. *Ney*, 12 a. m. *Silfverskiöld*, tandis que dans un cas on a pratiqué une ténoplastie atypique, l'auteur trouve que l'opération de *Silfverskiöld* a donnée les meilleurs résultats, puisque ce procédé, grâce à la position profonde du tendon et à sa direction favorable après la transplantation, permet la récupération de l'élément rotatif très important dans le mouvement d'opposition du pouce.

ZUSAMMENFASSUNG

Verschiedene Methoden zum operativen Rekonstruktion von der Oppositionsfähigkeit des Daumens nach Lähmung desselben, welche am häufigsten nach poliomyelitis vorkommt, sind angegeben. Während die Arthrodesse im Grundgelenk des Daumens (von *Spitzzy* angegeben) nach der Ansicht des Verfassers abzulehnen ist, da sie den Daumen zu einer Art Prothese reduziert, lässt sich oft mit Hilfe von Sehnenplastiken ein überaus günstiges Resultat erreichen.

Die besten Erfolge scheinen durch Anwendung des m. flexor pollicis longus für die Opponensplastik erzielt zu sein, wahrscheinlich weil dieser Muskel die genügende Stärke besitzt.

Auf Grund von 19 zur Aktivierung der Oppositionsfähigkeit des Daumens vorgenommene Sehnentransplantationen, von denen 6 a. m. *Ney*, 12 a. m. *Silfverskiöld*, während in einem Fall eine atypische Sehnenplastik ausgeführt wurde, findet der Verfasser, dass die Resultate nach *Silfverskiöld's* Operation am besten sind, da dieses Verfahren, sowohl wegen der tiefen Lage der Sehne als auch ihrer günstigen Richtung nach der Transplantation, eine Rekonstruktion der wichtigen Rotationskomponente in der Oppositionsbewegung des Daumens ermöglicht.

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