THE SUBSTITUTION OF THE MUSCULUS GLUTEUS MAXIMUS. A NEW OPERATIVE TECHNIQUE

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The m. gluteus maximus has two main functions; it extends the thigh when its point of fixation is the pelvis, and it raises the pelvis when its point of fixation is the thigh. The latter function is exercised, supported by other muscles, such as the hamstrings, when the trunk is brought from the flexed to the erect position. Should both points of insertion be points of fixation, the function of the muscles will be that of fixing the pelvis against the femur, as is the case when standing on one leg. In addition to these main functions, the lower part of the m. gluteus acts as an external rotator and adductor.

The loss of this muscle leads to severe functional damage. The commonest causes are poliomyelitis and spastic paralysis. Frequently, as a result of these paralyses, the flexors of the hip dominate to such an extent that it often becomes impossible to determine during an examination whether there is a real paralysis of the m. gluteus maximus, or only an insufficiency.

A paralysed m. gluteus maximus can never be replaced by apparatus. It is therefore easily understandable that repeated attempts have been made to replace the defective muscle by other muscles. *Lange* was the first to attempt a plastic operation using the m. erector spinae. He lengthened the mobilised muscle with silk thread to the insertion of m. glut. max. *Kreuscher*'s method is similar. *Ober* and *Hey Groves* substituted fascia lata

for the silk thread. *Dickson* transferred the m. tensor fasciae from the anterior to the posterior third of the ilium. *Wagner* and *Rizzo* shift the m. tensor fasciae, sartorius and the long head of the rectus femoris as far as possible to the posterior third of the illium. *Steindler* says of the substitution of the m. gluteus maximus: "as desirable as such a substitution would be, there is not at this time a real satisfactory method."

A possibility to obtain a functionally effective substitution for the m. gluteus maximus is presented by the ingenious principle of *Silfverskiold*. It consists of the transformation of a double-joint muscle into a single-joint one. This transformation is achieved by moving the points of fixation of the muscle. *Silfverskiold* based his conclusions on the observation, that a patient with *Little*'s disease is not able to straighten the knee without moving another joint at the same time. Even a healthy person can not straighten the knees when the hips are acutely flexed without straightening the hip at the same time. He calls this sign "compulsory movements with transmission effect". It arises from the fact that in the knee and hip joints, muscles such as the hamstrings, rectus femoris, and triceps bridge two joints.

This transmission effect is particularly marked in cases of spastic paralysis. A transplantation of the insertion of such a muscle eliminates the action on two joints, and concentrates it on one joint only. Such a transplantation of the insertion results in the elimination of "compulsory movements with transmission effect".

Silfverskiold himself applied this principle in several ways. He transferred the origin of the hamstrings from the tuberosity of the ischium to the femur. He detached the m. rectus femoris from the spina il. ant. inf., and fixed it to the femur; he transferred the m. gastrocnemii from the femur to the tibia.

Based on this brilliant idea, a substitution for the m. gluteus maximus through a transfer of the hamstrings was carried out successfully on two patients. In these two cases, operative techniques were used which will be described in connection with the case reports.

CASE REPORTS

J. A., boy of 12 years. Forceps delivery with asphyxia. All attempts with plaster and apparatus failed to enable the boy to walk. Boy's intelligence only fair, but according to the

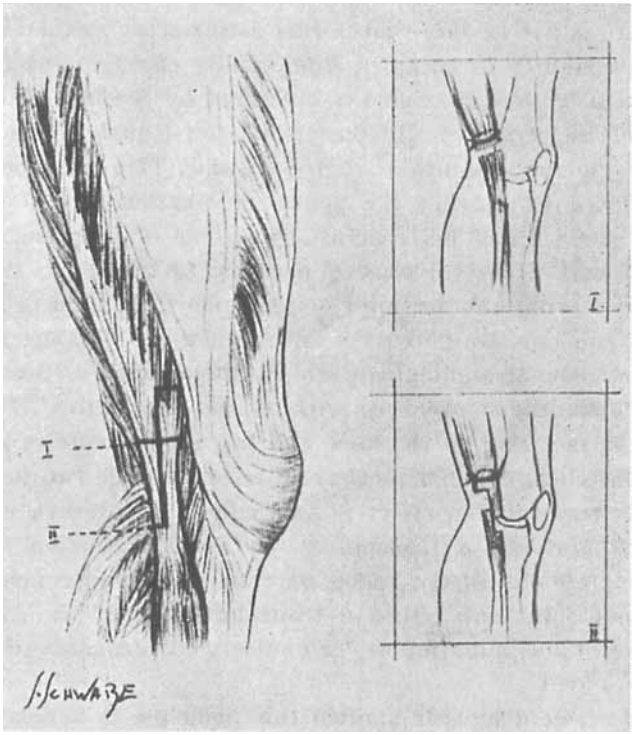

Fig. 1.
The substitution of the musculus glutens maximus.

parents, adequate for ordinary school requirements. Has to be wheeled to school. Incontinent up to the present day.

Examination: The patient cannot stand unsupported. When supported on both sides, he can take a few steps, but soon collapses. There are flexion contractures of both hip and knee joints, and the knee joints cross each other when walking. Total kyphosis of the spine. In the prone position every attempt to

extend the hip-joint results in increased flexion of these joints; the right more so than the left. No contraction of the m. gluteus maximus can be felt even when movement is assisted. Diffuse loss of muscular function all over the body. The neurological

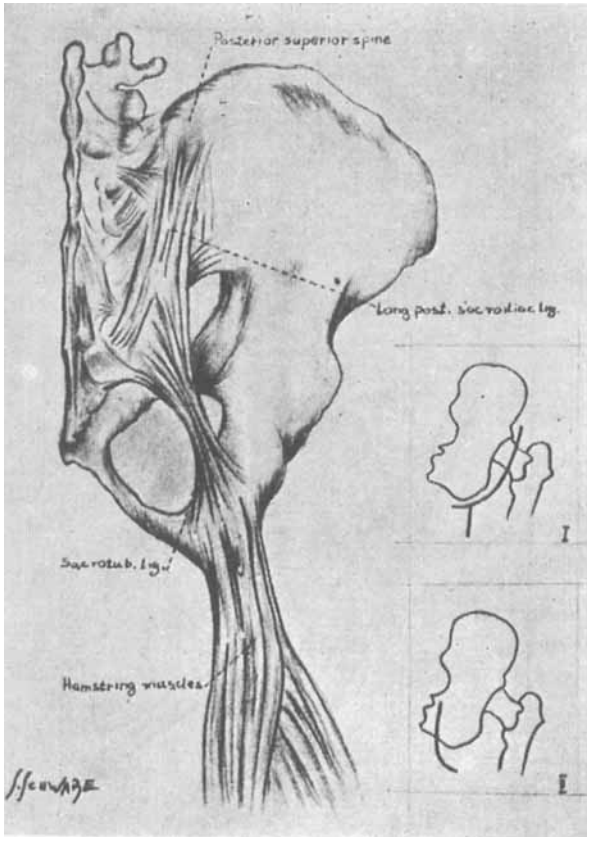

Fig. 2.
The substitution of the musculus glutens maximus.

examination showed massive spasms, athetosis, normal reflexes in both upper extremities; no spasms, but pyramidal signs in both lower extremities. Diagnosis: Cerebral damage at birth with cortical, pyramidal, and extra-pyramidal signs.

First operation: 15.3.1942. Right knee. The hamstring tendons were exposed by a posterolateral and posteromedial incision, severed, and the proximal ends were fixed to the deep fascia of the medial and lateral condyles. (Fig. 1, I.)

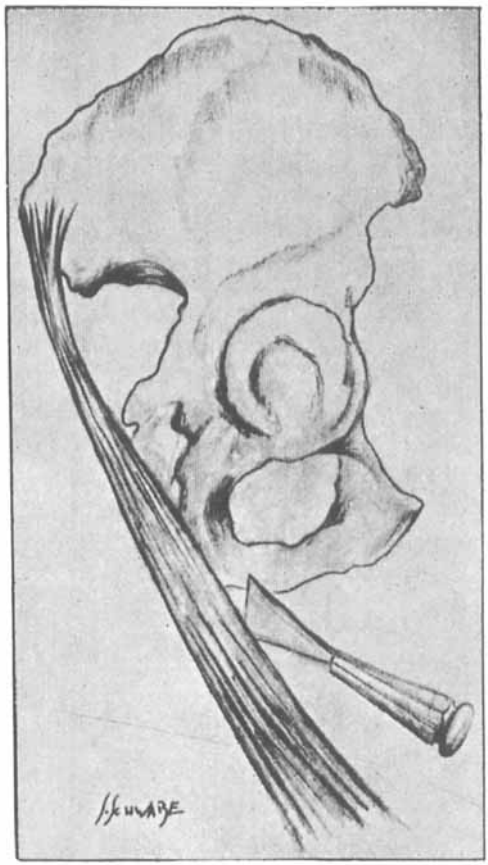

Fig. 3.
The substitution of the musculus glutens maximus.

Second operation: 20.12.1942. Right hip. Curved incision between the greater trochanter and the midsacral line, beginning above the trochanter and reaching the lower edge of the gluteus

maximus. From the curved incision, a longitudinal incision is extended distally. (Fig. 2, I.) The m. gluteus maximus is detached at its fascial insertion into the iliotibial tract. Beginning distally, the muscle is detached for about 6 cm upwards. The

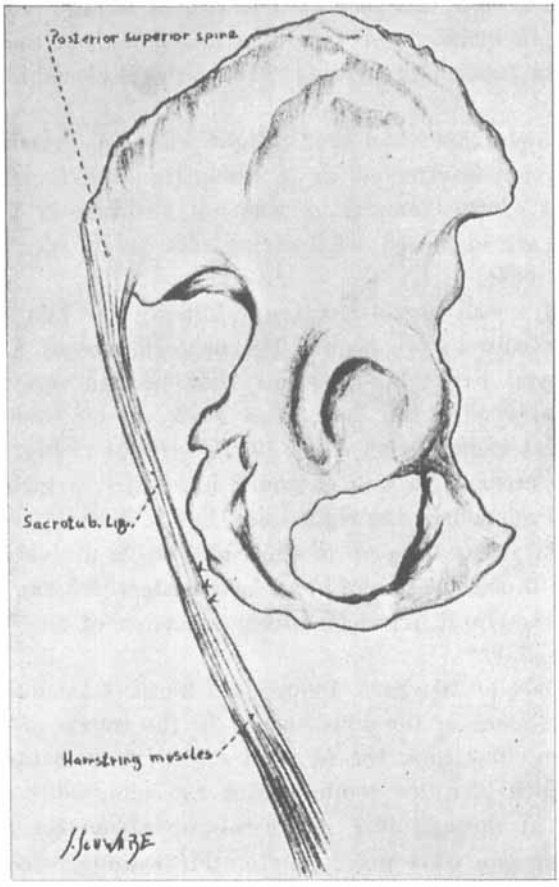

Fig. 4.
The substitution of the musculus glutens maximus.

muscle together with its bundle of nerve and vessels is retracted. The sciatic nerve is pulled laterally and the tuberosity of the ischium laid bare. (Fig. 2.) The common origin of the hamstrings

(which reach the tuberosity distally), and of the lig. sacrotuberosum (which reaches the tuberosity proximally) is detached with a flat chisel from the tuberosity of the ischium (Fig. 3). The free ends of the detached common origin are sutured together and a bone disc of ½ cm thickness is removed from the tuberosity in order to prevent a reattachment of the detached origin to the tuberosity (Fig. 4). The wound is closed in a routine manner.

Third operation: 31.1.1943. Right knee. A revision of the first operation is effected, as it seems that the fixation of the distal ends of the hamstrings was not sufficiently firm. Both insertions are anchored with string silk to the periosteum of the femur. (Fig. 1, I.)

After 8 weeks immobilisation following the last operation, walking exercises were begun. The performance of the patient has improved to such an extent that he can now walk for several hours with the help of a stick on an uneven sandy surface (last examination June 1946) without tiring. He walks completely erect, with well extended hip-joints. A genu recurvatum has developed in the right knee, but it does not impede the patient. The over-extension of the right hip is actively possible, and in the process a strong band is tensed, which can be traced as far as the ilium. An active over-extension of the left hip is still impossible.

M. Z., boy of 16 years. Protracted birth. Immediately after birth convulsions of the whole body. In the course of the years, these convulsions took the form of epileptiform attacks. Tenotomy of both Achilles tendons and the mm. adductores was performed at the age of 7. After this operation the boy began to walk. He can only utter inarticulate sounds, which are intelligible only to his father. He does not go to school, cannot dress himself, and has to be fed.

Examination: The patient stands with flexed knee and hip joints. The weight of the body rests only on the right leg, the left being abducted. After standing a few minutes, the patient collapses completely. The right hand can be used for rough movements, such as, for instance, wiping off the constant flow

of saliva from the mouth. The left arm, flexed at the hand and elbow joints, is held away from the body. When trying to walk with assistance, the right knee is not extended and is not lifted off the ground, while the left rests only on the tips of the toes. In this fashion, the patient succeeds in making a few steps without falling. In prone position the attempt to stretch the hip-joint results in an intensified flexion. There is no active muscular contraction in the m. gluteus maximus even when movement is assisted. The neurological examination showed brisk reflexes with spasms in all the extremities. Diagnosis: Cerebral damage at birth with spastic pareses of all four extremities, motor aphasia, epilepsy.

First operation: 20.3.1945. Right knee. The hamstring muscles are laid bare by a posterolateral and posteromedial incision, but not divided. The muscles are fixed on both sides to the periosteum of the femur with a kangaroo tendon.

Second operation: 1.4.1945. Right hip-joint. The tuberosity of the ischium is exposed by a medial, slightly-curved incision (instead of a lateral one as in the first case) carried along the origin of the m. gluteus maximus upwards from the third sacral spinous process. (Fig. 2, II.) The distal edge of the muscle is easily raised and the tuberosity is then exposed in its entirety. The hamstrings and the lig. sacrotuberosum are detached at their common origin as in the first case. The wound is then closed in the routine manner.

Third operation: 15.7.1945. Right knee. It became apparent that the fixation of the hamstring tendons was insufficient. Therefore the hamstring tendons were plastically lengthened during this second exposure, until the knee could be fully extended. The lengthened tendons were fixed to the femur with strong silk, without interrupting the continuity of the tendons. (Fig. 1, II.)

After 8 weeks immobilisation the patient started walking exercises. It was amazing to see how quickly this patient, who had no means of direct communication, learned to extend his right knee and hip-joints. He walks without assistance long

distances and can stand quite firmly on the right leg and move it normally (last examination June 1946).

DISCUSSION

Following *Silfverskiold*'s principle, an attempt was made to replace the loss of the m. gluteus maximus by the hamstring muscles. In order to achieve this aim, the hamstrings, which are flexors of the knee must be transformed into extensors of the hip. For this purpose the insertions of the hamstrings on the tibia and fibula must be transferred to the femur, and the insertions on the tuberosity of the ischium transferred to the ilium.

The manner of this transfer is described in the report on the operations. The operative technique has as yet many imperfections. In the first case reported, the flexors were cut in the hollow of the knee and the proximal ends of the tendons fixed first to the deep fascia and then, during the revision, to the periosteum of the femur. A genu recurvatum developed. Although this does not bother the patient, we wished to avoid it in the second case. Therefore the tendons were not cut in the second case, but fixed to the periosteum of the condyles of the femur with kangaroo tendons. This aimed at a new insertion without giving up the old insertion. This fixation proved to be insufficient, and at the revision, the hamstring tendons were lengthened plastically until the knee was fully extended. Only then were the hamstring tendons fixed to the femur. This form of "transfer of the insertion of the hamstrings" should keep the normal insertion on the lower leg bones, and in this way achieve a reinforcement of the posterior wall of the knee capsule and thus prevent the development of a genu recurvatum. The results in the second case justify these assumptions. A lateral approach to the tuberosity of the ischium was tried in the first case. It was complicated by the neurovascular bundle of the m. gluteus maximus and by the sciatic nerve. The medial approach, on the other hand, was simple and gave a clearer view. This approach is to be recommended in future.

None of the previously known methods of substitution for

the m. gluteus maximus have found wide application, and good results are as yet uncommon. All methods try to imitate the course of the m. gluteus. The transplanted muscle has therefore to function under the same unfavourable conditions of leverage as the normal muscle. Mechanically it is easier to replace the functions which the m. gluteus maximus performs, such as erection of the trunk, extension of the leg, fixation of the pelvis against the femur, by a pull in the long axis of the body. The technique described above has a further advantage in that it uses muscles and ligaments which are accustomed to pull. The normal direction of the transplanted muscles and ligaments is retained, and this makes the transplantation physiological.

Both patients are because of their mental state questionable subjects for this operation, although the operation succeeded. The indications for the operation were the social difficulties which the patients experienced. The real test for the operation will be the substitution of a m. gluteus maximus after poliomyelitis. While looking for suitable cases, it was observed that in our cases of paralysis of the m. gluteus maximus the hamstrings were also paretic. Therefore no attempts in this direction have been made up to the present.

SUMMARY

Following *Silfverskiold*'s principle, the transformation of double-joint muscles into single-joint ones is used to substitute the hamstrings for a paralysed m. gluteus maximus. The insertions of the hamstrings are transplanted from the tibia and fibula to the femur, and the origin on the tuberosity of the ischium shifted to the ilium with the help of the lig. sacrotuberosum. The operation has been attempted in oly two cases of spastic paralysis. No attempts on cases of paralyses after poliomyelitis have yet been made.

RESUME

Suivant les principes de *Silfverskiold,* la transformation d'un muscle double-articulaire en un muscle articulaire simple a été

appliquée pour remplacer par un tendon le gluteus maximus paralysé. Le tendon, tiré du tibia et du fibula a été transplanté sur le fémur et l'insertion de la tubérosité de l'ischion placée sur l'iliaque au moyen du ligament sacrotuberosum. Jusqu'à présent, l'opération n'a été pratiquée que dans deux cas de paralysie spastique. On n'a pas essayé de l'appliquer à des paralysies résultant de la poliomyélite.

ZUSAMMENFASSUNG

Den Grundsätzen von *Silfverskiöld* folgend, wird die Umformung eines Doppelgelenk-Muskels in einen Eingelenk-Muskel benutzt, um die Sehnen eines gelähmten m. glutaeus maximus zu ersetzen. Die Ursprünge der Sehnen werden von der Tibia und Fibula auf den Femur transplantiert, und der Ansatz am Tuber ischiadicum wird mit Hilfe des Lig. sacrotuberosum an das Os ilium verlegt. Die Operation wurde bisher nur in zwei Fällen von spastischer Paralyse versucht. Bei Paralysen nach einer Poliomyelitis wurden keine Versuche gemacht.

BIBLIOGRAPHY

Braus, H.: Anatomie des Menschen, Berlin, Verlag von J. Springer, 1921.

Campbell, W. C.: Operative Orthopedics, London, H. Kimpton, 1939.

Erlacher, P. J.: Die Technik des orthopädischen Eingriffes, Wien, J. Springer, 1928.

Silfverskiold, N.: Verhandlungen der deutschen orthopädischen Gesellschaft, 26. Kongress, Berlin, 1931, Stuttgart, F. Enke, 1932.

Silfverskiold, N.: zit. *Erlacher, P. J.*, page 282-285.

Steindler, A.: Orthopedic Operations, London, Bailliere, Tindall & Co. 1940.