THE TRANSPLANTATION OF THE RECTUS MUSCLE OR ITS SHEATH FOR THE CURE OF INGUINAL HERNIA WHEN THE CONJOINED TENDON IS OBLITERATED. THE TRANSPLANTATION OF THE SARTORIUS MUSCLE FOR THE CURE OF RECURRENT HERNIA WHEN POUPART'S LIGAMENT HAS BEEN DESTROYED*

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All surgeons admit a small per cent. of recurrences after operations for the cure of inguinal hernia even when the wound has healed by first intention.

After my study of the results of the operations performed at Johns Hopkins Hospital up until 1899 I felt convinced that the chief cause of recurrence in the lower angle of the wound was due to the fact that, whether the hernia was direct or indirect—the conjoined tendon was either weak or obliterated, and that the ordinary suture or closure of the defect in the abdominal wall was not sufficiently strong to protect from recurrence in the lower angle.

Reports on the ultimate cure of inguinal hernia previous to those of Halsted and Bassini were complicated by the suppuration of the wound. This factor undoubtedly was the chief cause of recurrence; for this reason lesser factors were not discovered.

Practically all surgeons who have contributed to the operative problem of curing an inguinal hernia recognize the importance of the conjoined tendon. From their description it is clearly evident that the conjoined tendon was caught in the lower sutures; the internal oblique muscle was sutured to Poupart's ligament; an effort was made to reduce the size of the external ring and make a snug external ring about the cord.

It is quite possible that the failure to cure depended more on the suppuration of the wound than any fault in the suture. McEwen apparently obtained the best results. In every case after his operations the wound was drained. This procedure may have limited infection. The results, however, must have been discouraging, because McBurney in this country left the wound open to heal by granulation. As far as I am able to ascertain, the results of this method were no improvement over the former methods. It is also quite possible that the brilliant results of Halsted and Bassini may have been due to the improvement in wound technic at that time and perhaps to the more perfect asepsis of their respective clinics, and not to the transplantation of the cord.

When I studied the results in Halsted's clinic I also found that when the wounds suppurated, which was not infrequent in the early years of

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the clinic, recurrence of the hernia was observed in from 25 to 30 per cent. of the cases. However, when the wound healed *per primam*, recurrence was reduced to less than 6 per cent. These recurrences were of two distinct types: One, in the upper angle of the wound, at the position of the transplanted cord, *when the veins were not excised*, usually a small affair, giving very little discomfort and rarely leading to second operation. In the second type the recurrence was in the lower angle of the wound, and my investigations at that time showed that this recurrence had no relation to the position of the cord. It was observed when the cord was and when it was not transplanted, or when the cord was excised or castration performed in older patients.

Fortunately, our excellent notes made before and during the operation on the condition of the conjoined tendon allowed me to conclude that the factor which led to the recurrence was the obliteration of the conjoined tendon at the time of the operation. I have observed both these types of recurrence in patients who have been operated on by the Bassini method, but as my experience with this method is limited entirely to recurrent hernias, I am unable, of course, to obtain any figures as to the exact percentages.

Unfortunately, when Halsted published his first contribution on the cure of inguinal hernia the illustrations and text emphasized the importance of the transplantation of the cord. Nevertheless, in my opinion, this was a minor part of the technic. In one of Halsted's publications he emphasized the importance of closing the defect in the inguinal canal as one would close the wound after any laparotomy—by a most careful suture of all the available fasciae and muscles without tension with interrupted silk. In Halsted's operation, after the division of the aponeurosis of the external oblique, the division of the covering of the sac, the complete excision of the sac and the closure of the peritoneal cavity high up, the internal oblique muscle was mobilized, so that the conjoined tendon and this muscle could be sutured to Poupart's ligament snugly without tension. During this period surgeons who operated had in mind apparently the transplantation of the cord, and many chose Bassini's method, because it appeared simpler and was less of an operation than Halsted's in which the internal oblique muscle was divided to allow a higher transplantation of the cord. But as far as I can gather, the chief features of Halsted's and Bassini's operation for the cure of inguinal hernia, were the painstaking closure and good healing of the wound.

The objection we found to silk for suture was the increased per cent. of suppurations or stitch abscesses. This led Halsted to change to silver wire which was followed by a better per cent. of healing. Suppuration of the wound, however, was not practically eliminated until gloves were worn at the operation, then it was found that we could return to the employment of silk as a buried-suture material. Due to the great im-
**Fig. 1.**—Illustrates the anatomy of the inguinal canal.
FIG. 2.—My original method of transplanting the rectus with transplantation of the cord—a method from which I got better results than later when the cord was not transplanted.
FIG. 3.—Halsted's modification of transplantation of the rectus sheath without transplantation of the cord.
CURE OF INGUINAL HERNIA

... and not fascia (Halsted's modification). During this period I paid much less attention to hernia and operated chiefly on recurrent cases, and my chief interest was centred on that small group of herniae in which the conjoined tendon was obliterated and which I attempted to cure by the transplantation of the rectus or its fascia (Halsted's modification). A careful following of this small group demonstrated that there was a certain per cent. of recurrences and that the transplantation of the rectus muscle and its fascia was not a certain cure.

During the recent war I had an opportunity to examine in Maryland a large number of selected service men who were placed in Group B because of inguinal hernia. It was very interesting to me to find that the per cent. in which the conjoined tendon was obliterated was about the same as I had found in 1899—5 per cent. As the majority of these selective service men volunteered to be cured of their defect in order to render service, I had an opportunity in a few months to operate on more than one hundred cases.

As I had had recurrences I felt that some modification must be made to the previous method. In this type of hernia, when one invaginates the scrotum and introduces the finger into the external ring, little or no resistance is met and the finger passes over the pubic bone, and, as a rule, can be pushed into the space of Retzius behind the rectus muscle. When this anatomical defect is present on both sides the two fingers meet behind the recti.

The weakness in the abdominal wall is therefore bounded laterally by Poupart's ligament and the rectus muscle, and below by the pubic bone. The firm and perfect closure of this opening is hampered by the presence of the cord.

When I first transplanted the rectus in order to suture it to Poupart's ligament and thus strengthen the defect in the lower angle of the wound due to the obliteration of the conjoined tendon, I also transplanted the cord and excised the veins as in the Halsted operation (Fig. 2).

Since my publication in 1899 we discontinued to transplant the cord and rarely excised the veins, and when this rarer type of inguinal hernia presented itself, we continued the method of transplantation of the rectus, usually with Halsted's modification of transplanting its sheath (Fig. 3), but we did not transplant the cord.

As far as I am able to ascertain, in the group in which I had trans-

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planted the cord (Fig. 2) there has been only one recurrence, but since
the change in technic of leaving the cord undisturbed in the lower angle
of the wound I know of at least four recurrences in operations which I
performed myself, and it seems strange that this made no impression.

The last operation performed by me of this later technic was May 20,
1918. But shortly after this operation a patient on whom I had operated
March 16, 1918, suffered a recurrence. This patient had a double direct
inguinal hernia; both conjoined tendons were obliterated. The herniae
were of the type of small reducible bubonoceles. In this case both recti
and their sheaths were transplanted, but the cord was left undisturbed.
It was this recurrence that led me to return to the first method of trans-
plantation of the cord, all but one by the Bassini method. It is too early
to judge of the result. All of these patients are in service and have not
yet returned.

Report of Case.—In the following case I transplanted the rectus
muscle and its sheath without transplanting the cord on May 20,
1918. The conjoined tendon was obliterated. The wound healed
per primam, the patient entered the army as an officer of the Quarter-
master Corps. He was discharged from the army in December, 1918,
and in February 20, 1919—ten months after operation—there was a
definite recurrence in the lower angle of the wound. For about two
weeks before the appearance of bulging there was definite local pain
in the region of the external ring.

Anatomical Findings at the First Operation.—The hernia was of
the type of a small bubonocele. The patient was a white male,
aged thirty-three, of good muscular development, a little over
weight, and of sedentary habits. One could pass the index finger
through a large and relaxed external ring directly over the pubic
bone into the space of Retzius. The hernia had been observed eight
months. No truss had been worn.

There was no hernia or weakness on the left side.

At the operation the external ring was found to be large and
split, corresponding to the findings before operation. Above the
cord there was a bulging between the internal oblique above, the
edge of the rectus to the medial side, and the pubic bone below.
This bulging was to the medial side of the deep epigastric vessel.
The bulging was covered with fat. It could be easily seen and
felt when the patient coughed or strained, as the operation was
being performed under local anesthesia. There was no distinct sac.
A triangular flap of the rectus sheath was turned down (Fig. 3), the in-
ternal oblique and rectus muscles were mobilized, and all of this tissue
was sutured to Poupart's ligament by two rows of chromicized cat-
gut. Then Poupart's was overlapped and sutured to the rectus
sheath and internal oblique. Then the aponeurosis of the external
oblique was folded over this line of suture and fixed to Poupart's.
This is the usual method of imbricated suture.

84
CURE OF INGUINAL HERNIA

In this case we had a small bulging of the type of a direct hernia. There was no evidence whatever of the conjoined tendon. From my observation this is the most difficult type of hernia to cure. When the bulging is small, the surrounding fascia and muscle have not been stretched and not thickened by inflammatory reaction, and although we attempt the so-called imbricated suture, we are not able to get much of an overlap, because the tissues have not been sufficiently stretched.

It is in this type that I have had recurrences before in spite of a most painstaking suture and making the ring as snug as possible about the untransplanted cord.

Anatomical Findings at Second Operation.—The recurrence was observed ten months after the first operation, and the second operation was performed two months later. The examination before this second operation was almost identical with that before the first. The finger invaginating the scrotum and following the cord passed over the pubic bone into the space of Retzius, but the tissues about the external ring were much thicker than before the first operation. The recurrent bulging and opening were above and to the medial side of the cord and admitted two fingers.

At the operation the wound having healed so perfectly, we could recognize and separate the anatomical structures just as clearly as in the primary operation. The recurrence was not due to any split in Poupart’s ligament on the lower side, or any split in the rectus sheath or muscle on the medial side, but was a definite opening below the line of suture along the cord. At this second operation I transplanted the cord as in Halsted’s method. That is, it lay between the subcutaneous fat and the aponeurosis of the external oblique. But I did not split the internal oblique muscle (Fig. 2). This was done, because the aponeurosis of the external oblique was somewhat thickened, and I felt that in view of the scar tissue the cord would be subjected to less pressure and would interfere less with the suture of the lower angle of the wound if I brought it out from the upper angle.

The results of the previous operation had produced thicker and stronger fasciae and in the imbricated suture I was able to get a wider overlap. The sac in this case was not opened, but somewhat isolated and reduced. In my experience in small direct herniae not much is gained by opening the sac, and when one pulls it out for high ligation there is some risk of injury to the bladder. I have no evidence to suggest that failure to open, partially excise and close a sac of this kind has anything to do with recurrence.

At this writing, about two and one-half months after operation, the patient is at work and apparently well.

Subsequent to the first operation upon this patient in May, 1918, I have always transplanted the cord when the rectus muscle and sheath had been transplanted, because of the obliteration of the conjoined tendon, and have usually followed the Bassini method of transplanting the cord.
I have been induced to present this paper before the American Surgical Association, not because the problem of the cure of this type of inguinal hernia is settled, but because of the apparent indifference of the majority of operators to make any change in the technic of their usual procedure, when there is every evidence that the chief weakness is in the lower angle of the inguinal canal due to the obliteration of the conjoined tendon, and not in the usual position, in the upper angle where the cord is situated, and through which the testicle descended.

I have read most of the contributions by surgeons operating in our various training camps for the cure of hernia in soldiers, and thus far I have failed to find a single mention of any change in the technic or to the conjoined tendon, or the transplantation of the rectus or its sheath.

I am confident that this anatomical defect is largely responsible for our recurrences, although these may be relatively few. Some definite change in technic must be made before the number of such recurrences is materially reduced.

There should now be an unusual opportunity, because thousands of men in the selective service and soldiers have been subjected to the operation for the cure of inguinal hernia.

*The Transplantation of the Sartorius Muscle for the Cure of Inguinal Hernia When Poupart's Ligament Has Been Destroyed.*—I observed some years ago that to completely excise the glands in the groin for primary or metastatic malignant disease, it was usually essential to completely excise that portion of Poupart's ligament corresponding to the inguinal canal.

In three cases of extensive cancer of the penis with metastasis to the glands of both groins, I removed by *en-bloc* dissection the penis, both testicles and cord, Poupart's ligament, everything in the inguinal canal and Scarpa's triangle. To fill the defect left by the removal of Poupart's ligament I divided the sartorius in the middle of the thigh, isolated it except at its upper attachment, placed it over the inguinal canal and sutured it in place.

One of these three patients is living more than five years since operation. There is no hernia on the right side; there is a small bulging and opening on the left side, which gives the patient no discomfort. This case appears to be a pretty good test of the value of this muscle transplantation.

More recently, in two cases of malignant pigmented mole of the leg with metastasis to the glands in one groin I performed the identical operation, except that the cord was not excised, but at least one-half of Poupart's ligament was excised from the pubic bone. One of these patients—an officer in the army—returned to full duty in the infantry. There is no weakness in the scar and no interference with the function of the limb. The result in the second case is equally good.
CURE OF INGUINAL HERNIA

It has recently occurred to me that this muscle could be utilized in some rare cases of recurrent inguinal hernia in which Poupart's liga-
ment has become practically obliterated by previous operation, but I have had no opportunity to carry out this idea since it occurred to me.

Note on the Transplantation of the Cord.—In the great majority of inguinal herniae where the conjoined tendon is wide and firm and where
the internal oblique muscle is well developed and can be mobilized, there
seems no difficulty in making a suture without disturbing the cord, or
ligating the veins, and the careful study of the results in these cases
demonstrates the correctness of this statement.

I feel confident, as already brought out in this paper, that when the weakness in the inguinal canal is in the lower angle due to the obliteration
of the conjoined tendon, a proper suture for a permanent cure can only
be done by separating the cord from its attachment and transplanting it
either by the Bassini or Halsted method.

There will also be a few other cases in which it would seem safer to
transplant the cord. In this group the conjoined tendon will be wide and
firm, but the internal oblique muscle will be found to be attenuated and
very difficult to mobilize.

I have just operated on such a case. The patient had been
operated on for appendicitis and drained some twenty-six years
ago. One year later a second operation was performed for
hernia in the scar. About one year after this second operation a
right inguinal hernia developed which finally became scrotal and
during the past year difficult to reduce.

Operative Pathology.—The patient was stout, the subcutaneous
fat thick and adherent to the aponeurosis of the external oblique.
The external ring was not very large, nor was the aponeurosis of
the external oblique relaxed. The sac contained omentum adherent
to the fundus of the sac. The omentum was ligated and reduced
through an opening which hardly admitted two fingers. The re-
mainder of the sac and omentum was removed. The cord in the
inguinal canal was larger in diameter than a man's thumb. The
internal oblique muscle was attenuated, largely replaced by scar
tissue and practically immovable. The conjoined tendon was wide
and firm. Poupart's ligament was thickened by scar tissue. This
cord was unusually large, and in my experience would act as a
factor in recurrence in either the upper or lower angle of the wound.
The size of the cord was reduced by isolating, ligating and excising
all but the vas and a few accompanying vessels. This mass was
composed of numerous thick-walled veins and scar tissue, much
larger than the usual varicocele. To excise this mass of veins it was
necessary to isolate the entire cord, so that the vas with its remain-
ing vessels could either be left in the lower angle of the wound or
transplanted. I found that I could make a better suture of the lower
portion of the wound by transplanting the vas, which I did according
JOSEPH COLT BLOODGOOD

to Halsted's method, as the aponeurosis of the external oblique was too attenuated to allow a good covering by the Bassini method.

It is of interest and importance to note here that when I reported on the results in the Halsted clinic in 1899, we were unable to find a single recurrence in the group in which the cord had been transplanted and reduced in size by the excision of the veins, and in which the conjoined tendon was wide and firm. The only objections to this method were a very few cases of atrophy of the testicle and hydrocele. But in my contribution I demonstrated that atrophy of the testicle depended upon hemorrhage from the lower stump of ligated veins, and with good technic the veins could be excised without any danger of atrophy of the testicle. But there is always the possibility of a hydrocele.

There should be no question in the mind of the surgeon or the patient that it is better to run the risk of a hydrocele than of a recurrence of the hernia, and I am confident from my experience that in some cases of inguinal hernia the cord should be reduced in size by a most careful ligation and excision of the veins, and in a small group the lower portion of the wound can be closed better by the transplantation of the cord. So far as I am able to observe, it makes very little difference whether this is done by the Bassini or by the Halsted method.