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Kind regards
of the author.

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 AND ITS OPERATIVE TREATMENT BY
 TRANSPLANTATION
 INTO THE
SCROTUM.
 BY
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ON INGUINAL TESTICLE, AND ITS OPERATIVE
TREATMENT BY TRANSPLANTATION
INTO THE SCROTUM.

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AS we know from embryological investigations, the testicle is found originally in the abdominal cavity below the kidney. It descends gradually, however, during the foetal development, apparently in consequence mainly of the traction of the so-called Hunter's guiding ligament (*Gubernaculum Hunteri*). This latter is a muscular elastic string arising from the lower posterior surface of the testicle and the epididymis, and branching off into three ends, one of which inserts itself at Poupart's ligament, the other on the anterior surface of the pubic arch, and the third, the longest, passes through the inguinal canal and takes root at the bottom of the scrotum. Under the influence of this striped muscle the "*descensus testiculi*" takes place within the foetal period. During the seventh month the testicle is situated behind the inguinal ring; during the eighth month the testicle commences to pass through the inguinal canal; with the ninth month the external inguinal ring has been passed, and after birth the testicle is found in the scrotum.

This normal *descensus testiculi* may become interrupted or retarded by several influences, some of which are not yet known, and then the anatomical relations of the testicle to the peritoneum and to the sheaths which form around the

testicle itself and around the spermatic cord must necessarily differ from the normal. If the testicle has remained high up in the abdominal cavity (abdominal testicle), we find it behind the peritoneum, enveloped by this membrane like the kidney, often so extensively that a mesorchium, which in some respects may be compared with the mesenterium, presents itself. The inguinal canal is empty, the corresponding half of the scrotum imperfectly developed. Such a condition generally is not lasting; usually at a later period the testicle descends further; this retarded descent, however, is seldom a complete one. As a rule, the retained testicle descends somewhat at the age of puberty, in some exceptional cases even later. The abdominal testicle is not seldom preceded by a peritoneal pouch reaching down into the inguinal canal. This pouch, to all appearances, consists in an independent development of the so-called Seiler's cœcum—that is, the extreme lower end of the *processus vaginalis peritonei*. This peritoneal pouch may facilitate the entrance of the testicle, and at the same time may be followed by formation of hernia. The testicle when located in the inguinal canal at birth (inguinal testicle), and remaining there, may give rise to symptoms at a rather early period. It temporarily swells, especially at the period of puberty, becomes painful, or descends further in the inguinal canal, leaving this canal at times and returning again at other times. In such cases we always find alongside of the testicle a more or less deep sac-shaped peritoneal pouch, the *tunica vaginalis*, into the branch of which the testicle and the epididymis are entered; the spermatic cord, remaining outside of this sac, is attached to the outer surface of the tunica-vaginalis-canal. Around this and the spermatic cord is further drawn a fibrous and a muscular layer. While the fibrous layer is given off exclusively from the walls of the inguinal canal, it appears that the muscular

layer (cremaster) originates partly from the muscular *gubernaculum Hunteri*. It is at least not unlikely that with the descent of the testicle both lateral ends, or bellies, of the gubernaculum, which insert themselves at Poupart's ligament and at the pubic arch respectively, attach themselves loop-like to the sides of the testicle and the spermatic cord, and, together with the muscular fibres originating from the oblique and transverse muscles of the abdomen, enter into the formation of the muscular hollow cylinder, the cremaster, which surrounds the testicle and spermatic cord. According to others, these ends, or bellies (the lateral ones), do not really belong to the gubernaculum, but are derived from the internal oblique and transverse muscles of the abdomen. At former anatomical examinations of fœtuses of different ages, however, I had opportunity to convince myself that they really belong to the gubernaculum. As we know from experience, the inguinal testicle possesses great mobility, it protrudes easily from the inguinal canal under the integument in front of the external abdominal ring, and likewise returns easily, not only into the inguinal canal, but also into the abdominal cavity. I am inclined to suppose that it is just the muscular layer spoken of which, by occasionally contracting, causes the frequent return into the abdominal cavity. This may, perhaps, be favored also by complete absence of the middle end of the gubernaculum. If this end is altogether unattached, the testicle necessarily not only does not enter the scrotum, but at the same time its return into the abdominal cavity must be facilitated. Under such circumstances it may sometimes be the case that the tunica-vaginalis-canal, together with the testicle, has been drawn upward, and at the same time has become inverted like the finger of a glove. But I believe that, as a rule, it, together with the testicle, is drawn back into a pocket of cellular tissue, formed before the internal aperture

of the inguinal canal by downward pressure of the peritoneum of the pelvic abdominal wall. So at least I found it in a case which I shall describe further down. Then the tunica-vaginalis-canal, drawn back together with the testicle, forms a sac situated in front of the peritoneum, into which—on account of its permanent communication with the abdominal cavity—occasionally a hernia may enter. It is possible that the testicle may return without the entire tunica-vaginalis-canal following, namely in those cases in which a sac-shaped pouch of the latter, below the testicle situated in the inguinal canal, reaches down into the scrotum. Under such conditions the testicle may return into the inguinal canal, not only when hanging within a mesorchium in the tunica-vaginalis-canal, and therefore possessed with more than normal mobility, but also when drawn back together with the nearest part of the tunica vaginalis only. There remains then in the scrotum below the inguinal ring a sac-like pouch of the tunica vaginalis, even when the testicle has completely returned into the inguinal canal; within this pouch, alongside of the testicle placed somewhat higher, we may find sometimes the spermatic cord hanging down in the shape of a downward directed loop. Only recently I had an opportunity to observe this state of things in a patient after reposition of an inguinal testicle into the abdominal cavity. In such cases sometimes we find also a portion of intestine or omentum in the open tunica-vaginalis-canal. This may, passing the testicle, enter into that part of the tunica-vaginalis-sac which extends lower down, and located there, it appears that it may prevent the descent of the testicle further down into the scrotum. More frequently than in this form we observe hernia behind the testicle, intestine or omentum having entered behind the testicle into the open tunica-vaginalis-canal.

These frequent complications of the inguinal testicle with

hernia have, perhaps, as often been the cause of error in diagnosis between inguinal testicle and hernia, as the location, the mobility and other symptoms of inguinal testicle, but the true state can be very easily discovered by careful examination of the scrotum and the inguinal region. The corresponding half of the scrotum is empty. The scrotum surrounds only one testicle, grasping it pretty tightly. The inguinal testicle forms in the inguinal region a roundish-oval, more soft than hard swelling, with several strings of vessels which are continued upward. As a rule, it has been arrested in its development, is small and of infantile condition, though it may not always remain in the low state of development corresponding with the foetal period at which the development was interrupted. The epididymis and the spermatic cord, however, are developed to their normal size and these formations appear, in consequence of the smallness of the testicle, generally of unusually large and massive development. The small inguinal testicle reacts upon pressure as lively as a testicle of normal development, indeed, I have not seldom observed a much greater tenderness of the same. This tenderness is very characteristic, and distinguishes the inguinal testicle very well from an omental hernia, which would be the thing most liable to be confounded with it. In my opinion, a hernia co-existing with the inguinal testicle may render the diagnosis somewhat more difficult only in such cases in which the hernia, after having passed the inguinal testicle, has entered deeper down into the tunica-vaginalis-sac. But, after reduction of the hernia, which, on account of the relatively great width of the canal of the vaginal process, does not generally happen to be difficult, we may soon be able to inform ourselves of the real state of affairs. The absence of the testicle in the corresponding half of the scrotum, the presence of a soft or moderately firm, roundish

body, with vascular strings, often coil-like, surrounding it and continuing themselves towards the abdominal cavity, and the characteristic tenderness of this body at the external inguinal ring, or in the inguinal canal, are pathognomonic. If, as it not seldom happens, the inguinal testicle has been pushed out of the inguinal canal by cough or pressure, it is apt to be confounded with omental hernia, but can also easily be distinguished therefrom by the symptoms enumerated. Besides, omental herniæ, do not generally possess the lively mobility which is quite characteristic of the inguinal testicle. If this mobility is lost in consequence of inflammatory processes, the distinction, on the other hand, is facilitated by the swelling, the enlargement and the firmness of the testicle.

All patients with movable testicle retained in the abdominal cavity, or in the inguinal canal, sooner or later experience varying complaints necessitating our interference. Whenever such a testicle, leaving the abdominal cavity, or returning again from the scrotum, enters into or passes through the inguinal canal, it suffers, as a rule, a more or less severe pressure from the firm walls of the inguinal canal, which pressure is always accompanied by a characteristic sensation of pain. This pain, especially while the testicle is pushed through the external or internal aperture, is described sometimes as quite similar to that of concussion of the testicle. These pains of incarceration are the more troublesome, as they repeat themselves most frequently, though not always, with equal severity; in some cases with every violent movement, with stooping down, pressure, running, jumping. As a rule, the sensation of pain soon passes away, but it may become so intense that the patients vomit, faint, etc. This I observed only recently in a case. It is comprehensible that under such circumstances we at first suspect incarcerated hernia, and it is necessary to make the

examination the more carefully, because inguinal testicles not seldom are accompanied by herniæ. If we do not at once attempt reduction, but first examine the parts very carefully, we soon will discover the true state. In the case of incarcerated testicle the symptoms readily disappear if the patient is laid horizontally with relaxed abdominal walls and if cold applications are made. Usually, however, there remains an extraordinarily increased tenderness of the testicle in patients with movable inguinal testicle. The slightest touch sometimes is painful.

The frequent incarceration of the inguinal testicle, besides these troubles, gives rise to œdematous or inflammatory swellings of the testicle and the tunica vaginalis, to hydroceles, etc., whereby the complaints are augmented. It is, further, easily comprehensible that accompanying herniæ increase the difficulties of the inguinal testicle by their causing a constant pressure on the same. Occasionally there also may happen incarceration of hernia. Finally, it is a fact established by experience of long standing that testicles interrupted in their normal descent, and especially the movable inguinal testicle, in relatively a great number of cases, become attacked by malignant new formations, by sarcomas and cancers, which fact, according to Cohnheim, we may well bring in connection with the interruption of development and growth of the testicle, which, as stated above already, are accompanying symptoms of the interrupted descent. Cohnheim, as is known, supposes that the retained testicle shows a great inclination to formation of malignant tumefactions because "the existing germs of growth, on account of the retention, have not attained their regular development."¹

All these difficulties and secondary diseases of the in-

¹ *J. Cohnheim*, Vorlesungen über allgemeine Pathologie. Berlin, 1877. I. Bd., p. 643.

guinal testicle make remedies and help desirable. In the case of abdominal testicle we may, as a rule, find no cause for interference before it has entered into the inguinal canal—that is, before it has become inguinal testicle. As a general thing, first a truss is recommended, either with the intention of pushing the movable testicle down into the scrotum, or for the purpose of keeping it back in the abdominal cavity. In the latter case, after reposition of the protruding testicle has been made, the truss is to be worn on the external inguinal ring, while in the former we have the pad lying above the testicle, which has been protruded from the external aperture of the inguinal canal, thus to push gradually the testicle downward and to prevent its sliding back. For this end, the application of trusses with fork-shaped pads is thought especially useful. Even if a success has been obtained in some cases by this treatment, we must not expect too much from it. In spite of the best constructed truss, the testicle occasionally will slip back into the inguinal canal, or from this it will glide from under the pad, and it is readily understood that under such circumstances a truss can be not only of no advantage, but must directly do injury by increasing the difficulties of incarceration. In general, I do not believe that the occasional entering of a movable testicle from the abdominal cavity into the inner opening of the inguinal canal can ever be prevented completely by means of a truss. If a hernia protrudes behind or alongside an inguinal testicle, the difficulties of the treatment by truss become still greater, and the results attained by the same very imperfect and unsatisfactory. The trusses with hollow pads, which have been recommended for this complication, are equally inefficacious to prevent the occasional incarcerations of the inguinal testicle. In view of this inadequateness of the treatment by truss in cases of inguinal testicle, I feel justified in recom-

mending instead, for proper cases, *the bloody transplantation of the testicle into the scrotum*.¹ By this operation, however, I do not mean the mere attachment of the testicle in the scrotum by means of suture—a method which might be of only little reliance. I am of the opinion that, above all things, the influence of the cremaster upon the testicle has to be annihilated, and the passage of the inguinal canal obstructed. As is easily to be seen, a reliable and lasting fixation of the testicle in the scrotum, therefore, can only be secured when, in addition to the division of the muscular envelope of the spermatic cord and the tunica vaginalis—after the vessels of the spermatic cord have been isolated—the tunica-vaginalis-canal also, at the orifice of the inguinal canal, and the external opening of the latter itself, have been closed by means of the suture. Only then is it to be expected that the testicle, attached by means of suture, no longer being pulled at, will permanently remain in the scrotum; the sliding back into the inguinal canal is made completely impossible.

After this plan of operation, I have, in a vigorous lad of 20 years, transplanted, with completely favorable result, a movable right inguinal testicle, which was resisting all treatment by trusses, from the abdominal cavity, whither it had retracted itself at the time, into the corresponding half of the scrotum.

To prepare the patient, a purgative is given the day before the operation, or the intestines are washed out by means of a rectal tube. In the morning, before the operation, the patient should take a warm bath, and the whole pelvic region be most thoroughly soaped and cleansed. The operation is to be made under strictly anti-septic precautions.

¹ *Kocher* states that *Rosenmerkel* and *Chelius* have already attempted, without success however, the bloody transplantation of the inguinal testicle. I have not been able to find the description of their method.

The method of operation is as follows: If, as in my case, the movable inguinal testicle has slipped back into the abdominal cavity, and the anterior aperture of the inguinal canal is found completely empty, we divide exactly as in incision for hernia, integument and fascia over the external inguinal opening, continue the incision down into the empty half of the scrotum, divide the loose cellular tissue covering the aperture, and pass the fingers through the inguinal canal into the preperitoneal space, in the wall of which the retracted testicle is lying. It is difficult to feel, as it is usually small; it is, however, easily recognizable by the strings of vessels of the spermatic cord, which generally are strongly developed. This mass is hooked with the index finger, drawn against and finally passed through the inguinal canal. Within this mass the testicle is found. It can now easily be felt within its coverings. We next draw a thread-loop through the sac-shaped extreme lower end of these coverings, for the purpose of holding the testicle well outside of the inguinal canal. We then divide in a longitudinal direction, commencing from the inguinal ring, down to near the testicle, the muscular and fibrous coverings in which, as in a sac, the spermatic cord and the testicle are lying, and divide also the tunica vaginalis. After this, follows the isolation and mobilization of the spermatic cord: Carefully avoiding the vessels and nerves of the spermatic cord and vas deferens, we divide, in a horizontal line, somewhat above the testicle, the tunica vaginalis, and likewise the muscular and fibrous coverings of the spermatic cord, and loosen the same a little way, like a ring, from off the spermatic cord; we may even remove a piece of these coverings. As soon as this has been done, the testicle and the spermatic cord, *without the slightest difficulty*, can be drawn as low down as is required. The testicle remains down, and cannot retract itself again. Then follows the fixation of the testicle to the bottom of

the scrotum, by means of suture. We fasten it by the application of some cat-gut sutures passing through its posterior and lower surface, in such a manner that it rests on a base as broad as possible; in addition, we pass some lateral sutures from it through the integument of the scrotum, and tie the same outside on the tegumentary surface (mattress sutures) to secure as firm a fixation as possible, of the testicle in its new bed. The next act of the operation is that of the occlusion of the tunica-vaginalis-canal and of the external inguinal ring. We first pass a finger through the open tunica-vaginalis-canal, into the abdominal cavity, and push back any part of intestine or omentum that may protrude. Then an assistant draws the divided tunica vaginalis, just in front of the external inguinal ring, firmly asunder, and by means of an aneurism-needle, we apply a constricting cat-gut suture in such a manner that, beginning at the one cut surface of the tunica vaginalis, we pierce the needle at short intervals of $\frac{1}{4}$ - $\frac{1}{2}$ c.m. in and out until we arrive at the other cut surface and the thread has been passed through the whole width of the tunica vaginalis. To effect greater security, there may be applied, in the same manner, a second suture closely below the former. Naturally enough, when the needle is passed in and out care must be taken that it passes through nothing else but the tunica vaginalis, which, however, can be done easily. Now follows a renewed examination of that part of the tunica vaginalis which is open towards the abdominal cavity, while the assistant, by digital pressure from outside upon the inguinal ring, prevents the protrusion of viscera; the thread ends of the constricting suture are tied firmly together, whereby the tunica vaginalis at the point of constriction is drawn together, tobacco-bag like. This suture, which I have often applied in the same manner, after herniotomy, holds very tightly, and cannot slip off. The parts constitut-

ing the spermatic cord remain outside of the suture. After this, the pillars of the external inguinal ring are brought together by means of some interrupted cat-gut sutures, either so near, that this opening, which is generally very wide, is closed tightly around the spermatic cord, or only so near that there is room yet for a narrow drainage tube to be placed in the preperitoneal cellular-tissue space. Finally, we insert a drainage tube into the lower part of the tunica-vaginalis-sac as far downward as to the testicle, and close the wound of the integument and the soft parts, by means of silk suture as far as to the point where the ends of the drainage tubes are passed out. Over this is applied Thiersch's salicylized jute, or Lister's gauze-bandage, covering, besides the sexual organs, the whole pelvis, and leaving free only penis and anal opening. For the purpose of preventing soiling of the dressing and to be able to leave the first bandage undisturbed as long as possible, the urine, during the first days, is taken away by means of a soft *Nelaton's* catheter, and an opiate is administered to the patient.

In my case there happened, while there was absolute absence of fever, union by first intention, except at that point at which the drainage tubes were located. A firm cicatrix formed itself. The testicle remained in the scrotum, and, which is most remarkable, *resumed its growth*, which for so long a time had been retarded. At the time the patient was dismissed (four weeks after the operation), it had the size of a large walnut, and was completely painless.

If the testicle is located within the inguinal canal, the method of operation needs no essential modification. If the testicle is located closely before the external inguinal ring, the above described searching for the testicle, it is unnecessary to say, is done away with. We proceed directly to the testicle; otherwise, we operate in the manner described.

This method of operation is equally adaptable to those cases in which the inguinal testicle is accompanied by a hernia. In such cases we shall have to divide first the hernial sac, reduce the contents of the hernia, and then isolate the spermatic cord, transplant the testicle into the scrotum, and further finish the operation in the above described succession.

This operation, in cases complicated by hernia, as well as in those where only difficulties of incarceration of movable inguinal testicle exist, is certainly to be preferred to that of extirpation of the testicle, which latter operation has long been proposed for cases resisting treatment by truss, and which, too, has been performed several times. Our operation preserves the organ, transplants it to that very place which it occupies under normal conditions, prevents the retraction of the testicle, protects it against incarceration and against the diseases caused thereby, and enables us at the same time to keep back accompanying herniæ reliably and permanently.

If it becomes confirmed, by future operations, that the testicle, having been arrested in its development, grows and attains its normal size after its transplantation into the scrotum, as in our case, this fact, as is readily comprehensible, would not only be of theoretical interest, but certainly of practical value also, since, to all appearances, this increase in size depends on the growth of the parenchyma of the testicle. I draw this conclusion from the absolutely normal condition of the testicle of the patient operated on by me. We may, therefore, be allowed to expect that the inguinal testicle by its transplantation may regain, together with its normal size also, its ability of function. If such, however, is the case, it follows by itself that, as long as the inguinal testicle is healthy, castration must not be performed, but transplantation into the scrotum should be resorted to in preference.

Simple inflammatory processes of the inguinal testicle offer no contrary indication to the operation. It may well be performed after the inflammation has subsided.

Perhaps the inclination of retained testicles to the development of malignant new formations is lessened with the resumption of normal growth after the transplantation of such testicles into the scrotum. According to Cohnheim's views, with whom we concur, such, indeed, should be expected; for, after the transplantation, as our case shows, "the existing germs of growth of the testicle may assume *regular* development." Even if we may not have to allow ourselves illusions in this regard, we may, nevertheless, find in these ideas a further inducement to perform the operation.

Greifswald, July, 1881.

