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STUDIES IN THE TECHNIC OF TESTICULAR TRANSPLANTATIONS.

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STUDIES IN THE TECHNIC OF TESTICULAR TRANSPLANTATIONS.*

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In view of the fact that at present there exists a definite set of clear indications for the practice of testicular implantation in man, as pointed out by the writer before the International Congress of Comparative Pathology recently held in Rome, Italy, I shall endeavor to give you the results of my work in testicular transplantations which have been evolved from constant study and investigation in the period between 1919 and 1923.

A. The Materials Used for Sex Gland Implantation: A Discussion of Their Value.

I. *Human Implants:*

When the question of sex gland implantation has been decided upon, the next phase to consider is the best material to use for a given case and which transplant, or implant, will yield the very best results. All observers and workers in this field unanimously agree, of course, that the *best material for implantation is human glandular tissue.* However, in obtaining the proper human material a number of obstacles present themselves. In the first place, the following important factors must be kept constantly in mind:

First: The age of the donor.

Second: The absence of pathological conditions within his body (syphilis, tuberculosis, malignancy, etc.).

Third: Under what circumstances has the implant been obtained, and how was it treated immediately before implantation?

As to the age of the donor, it is, of course, best to obtain testicular tissue from an individual who is neither too young nor too old. I would say that the ages between nineteen and thirty-five would be most favorable. It must be kept in mind that sexual maturity is arrived at in some individuals earlier than in others and, again, sexual virility is extinguished in some persons at an earlier age and retained for a longer period in other individuals. The best rule to adopt in this connection is to select a donor who is known to be at a period of sexual maturity and activity in a normal and active manner. A thorough examination of the donor as to the presence or absence of syphilitic taint, the presence or absence of tuberculosis and the presence or absence of other communicable diseases or systemic aberrations, is necessary, for these are criteria which are to be very earnestly considered. The general physical condition outside of the *vita sexualis* is equally of paramount importance. It would be malpractice of the grossest kind to implant into a normal individual the testes of a syphilitic or the testes of an otherwise frankly diseased person.

The third problem presenting itself is: Has the donor earnestly consented to part with a portion of his sex gland to help someone in physical need of such aid; or is he simply parting with it for a monetary consideration? In my opinion the latter practice offers objections. The reason for this is that under stress of poverty young individuals may part with one, or part, of their sexual glands and later regret their action and, perhaps, become remorseful or introspective. Although the fact has been thoroughly established that an individual can continue throughout life with one testicle just as well as with two, yet these facts are known principally to physicians and the uninitiated may attribute every ailment that may befall him later in life as the direct result of the loss of a testis from which he has parted for pecuniary reasons.

On the other hand, inasmuch as close blood relationship, say between father and son, is the best tissue for implantation purposes, the question naturally presents itself: Cannot the son who owes his very existence to his father part with a portion of one of his testes should the father need it for his well-being and usefulness? The donor may in turn expect the same therapeutic help from his own son. The same rule may apply to near relatives. If such arrangement can be effected the full understanding of the question at issue must be impressed upon the donor emphasizing that only a portion of one testis will be required and that the amount of testicular tissue remaining will be sufficient to carry on the functions of internal secretion and propagation in a normal manner and without in the least jeopardizing his somatic and sexual functions.

Some observers have made use of testicles of young individuals who have died by accidental means. If disease in these individuals can be absolutely ruled out, and, above all, if the implantation can be done within a reasonable time after the death of the donor, such method has been successfully resorted to by the author.

II. *Implants from Animals Other than Apes:*

An attempt has been made in certain quarters to transplant testes from rams, goats and animals of similar specie into the human economy. Reports from serious investigators in this field have shown absolute failures in the vast majority of cases. *Experimental investigations conducted by the essayist on this question have resulted in all instances where testes of these animals were used for transplantation in absolute failure; to-wit: necrosis of the implant; liquefaction or suppuration with final extrusion of the transplanted testis.* This is not to be supposed for, if we study the results of investigations [illegible]

*Read before the Royal Academy of Medicine, Rome, Italy, October 13, 1923.

relationships between the human and the lower forms of animals a wide divergence at once appears and an insurmountable biologic gap is encountered. Furthermore, a histologic comparison between the blood elements of these animals and humans will show the greatest variation and disproportion. In other words, the implantation of sex glands from these lower animals into the human body is a physical, physiological and biologic impossibility and in view of my own researches and those of other investigators it is a fallacious undertaking and should *never* be attempted because biochemically and structurally the hiatus has thus far remained unconquerable.

To recapitulate: *For transplants to be successful they must come from a member of the human family or its nearest biologic relations—the higher apes (anthropoidea) of which we shall speak directly.*

III. *Implants from Higher Apes*:

The most logical animals to serve the purpose for implantation, next to the *homo sapiens*, as donors, are the groups belonging to the anthropoidea. Of these the chimpanzee and the ourang outang are most desirable. To Serge Voronoff, of Paris, France, belongs the credit, unreservedly, of having pointed out to the scientific world that in the absence of, or in the case of impracticability of, human specimens for implantation, we may resort with success to the animals under discussion, *i. e.*, the higher apes. Experimental studies and the comparison of the embryology, dentition, analogy of the skeleton and visceral relationship, as well as the histology of the internal organs, have caused him to conclude that the possibilities of implantation from higher apes to humans may be successfully accomplished. This has been proved by Voronoff and myself from a number of transplantations so carried out, to be a fact. In comparative studies between anthropoid apes and humans, Voronoff is upheld by Gruenbaum, Uhlenhut, Bruch and others. Clinical manifestations verify the feasibility of such implants in cases subjected to this treatment. In following up Voronoff's work I was able to prove by implanting a number of testes from this class of apes into humans that the implants do live and clinically give results akin to those obtained from homotransplantation.

The difficulty of obtaining these animals at the present time is due to conditions created by the world war and is a rather difficult task. Occasionally, however, one can obtain a specimen or two. In procuring a proper animal the very same rules as to the investigation of its health must apply as though the donor were a human being. A thorough examination of the lungs is indispensable. The proper age of the donor must be ascertained. *The prepuberal period bars the animal as a donor. The period of sexual maturity is the desirable age.* As soon as the beginning signs of senescence in the animal are observed it is to be discarded as a donor for implantation.

I have made use of some of the animals above referred to and in their absence, through difficulties in procuring same, I made use of the class of apes known as the *cynocephali.* This class is very closely related to the above mentioned group and classified by Hartman as "anthropoidea." The blood relationship in these apes in very close and histologically the same as in the higher anthropoids and humans. The lower forms, such as the small rhesus, lemurs, ringtails, etc., are entirely to be discarded for implantation purposes. (The giant rhesus forms an exception.) Their blood agglutination tests are too distant, their life cycle and *vita sexualis* too remote to give the desired results and to be of proper therapeutic value in this work. (Fig. 1.)

It is a wise plan to select the proper animal and keep it under observation for about a week. From experience I have learned that immature animals were sold by unscrupulous dealers which were discovered to be in the prepuberal or senescent stage and therefore unfitted for the purposes for which they were desired. A female of the same species if kept in the cage with the animal to be used as a donor will very frequently cause the observer to ascertain the sexual aggressiveness, disposition of external genitalia, general health, etc. All these

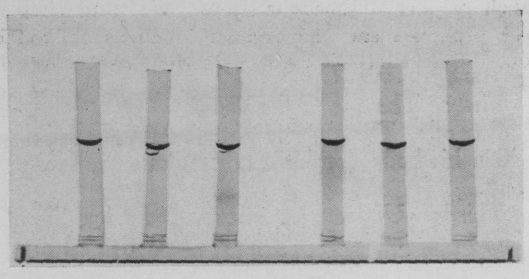

Fig. 1. Test tubes showing reaction.*

Tube 1 (*Control*).
Anti-human rabbit serum plus isotonic salt solution. No clouding at zone of contact.

Tube 2 (*Control*).
Anti-human rabbit serum plus normal rabbit serum—1:100. No clouding at zone of contact.

Tube 3 (*Control*).
Anti-human rabbit serum plus normal human serum—1:100. Marked clouding at zone of contact. Slight precipitate.

Tube 4.
Anti-human rabbit serum plus serum of Cynocephalus (baboon) 1:100. Moderate clouding at zone of contact.

Tube 5.
Anti-human rabbit serum plus serum of giant rhesus (macacus rhesus) 1:100. Faint clouding at zone of contact.

Tube 6.
Anti-human rabbit serum plus serum of macacus rhesus 1:100. Almost imperceptible clouding at zone of contact.

*Experiments carried on by author to prove blood-relationship between humans and anthropoideae.

facts must be carefully weighed and every angle thoroughly considered for a proper selection of the material to be used.

B. The Relation of the Quantity of Interstitial Substance to the Intensity of Its Secretory Action.

Lacassagne (1) has shown that there is an accentuation of the sexual activity in individuals who have an increase of the interstitial elements of their testes. Such increase has been observed in cryptorchids, as well as after transplantations, after ligations, and as a result of roentgenization.

These findings of Lacassagne have been verified by the studies of Steinach (2), as well as those of Sand. On the other hand, Alfred Kohn (3) denies such effects, pointing out that the relation of virility to the activity of the interstitial substances, as asserted by the above authors, does not behave as stated by these observers. Alexander Lipschütz (4), arguing the question, points out that during the metabolic processes in the organism only such proportions of a given substance are utilized by the body as are necessary for the function or functions in a given instance, and that a superproduction of such products is either oxidized or eliminated. In other words, these secretory products, like the various aminoacids or the various ions having specific biochemical functions, are not necessarily exercising such biochemic functions by an over production in the organism and the organic functions depending upon their production; nor do they cause disturbances in metabolism, provided certain limits are not exceeded. Such increased supply results only in greater demands upon the digestive, resorbent, circulatory and excretory organs and in the course of these events a marked increase in oxidation ensues. Lipschütz compares these bodies to the introduction of other toxic products into the system, such as morphin, for instance, in which case gradual administration in minute doses will permit the organism to accommodate itself to the drug so that after a time enormous doses are not followed by toxic manifestations. Of course, a suddenly increased supply of the testicular hormone may so stimulate the organism as to increase sexual functions greatly, as exemplified in animals during the rutting period.

From experimental work on lower animals and humans it has been established (Lacassagne, Steinach, Voronoff, Sand, Thorek and others) that there is an increase in interstitial elements and simultaneously with such increase there is increased psychosexual and somatosexual capacity.

There is a certain group of observers who point out a certain parallelism between the quantity of the testicular substance and corresponding intensity of secretory function. Steinach insists that it is not as much the quantity of the testicular as the amount of interstitial elements that plays the important rôle in the development of secondary sex characters.

Lipschütz affirms that such interdependence holds true only to a certain point, after which the intensity of the action of the internal secretion is mitigated or nullified. He expresses his views graphically by a schematic representation of existing conditions. (Fig. 2.) Of course, Lipschütz pleads for more proof to verify his hypothetical suggestions exemplified in his graphic illustration. I am inclined to agree with Lipschütz that the autonomic regulation of body functions on a physiologic basis will consume only that quantity of internal secretion necessary for their immediate needs, storing a great deal in the central nervous system, and that a great surplus will be eliminated from the body through the usual emunctories.

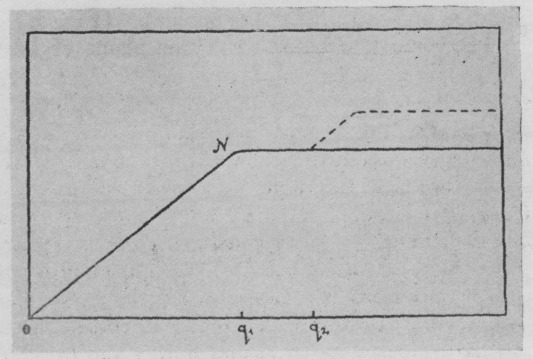

Fig. 2. Diagram of Lipschütz.

Abscissa.—Quantity of internal secretion of sex gland.
Ordinate.—The internal secretory action as represented by the development of somatic sex characters.
Q-1.—Quantity of internal secretion through which the normal development of secondary sex characteristics (N) develop.
Q-2—Quantity of internal secretion normally reaching the circulation.
Dotted line.—Transitory increased action observed during rutting period.

Fig. 2. A Graphic Scheme to Illustrate the Relations Between the Quantity of Internal Secretion of the Male Sex Gland and the Intensity of the Manifestations of Internal Secretion. (After Alexander Lipschütz.)

The proportionate secretory function of the action of the quantity of the internal secretion of the sex organ is seen in the space between 0 and q.1. If the quantity of internal secretion should rise above q.2, temporarily, the result will not be a permanently increased secretory function (prolonged line). A transient rise above q.2 leads to a transitorily increased action such as is observed during the rutting period (dotted line).

C. Site of Implantation.

The site of implantation plays a rather conspicuous rôle in transplanting sex glands for thera-

peutic purposes. If we analyze the sites of implantation resorted to by various authors two prominent features impress themselves upon the careful observer. First, that a great number of implants have either suppurated or have become extruded. Second, that there is too rapid regression in the size of the implanted testis.

Lydston did an extravaginal implantation. In other words, in experimenting upon himself and advising implants upon others he placed the testis in a pocket situated between the skin and the parietal layer of the tunica vaginalis of the testis. In his reported cases numerous suppurations were noted and the testicle implanted into himself was lost to a very great extent through necrosis and suppuration.

Voronoff implants the testis with the cut surface of the implant against the tunica albuginea. He also has observed in some cases suppuration and extrusion of the implant. (Fig. 3.)

The same fate befell some transplants of Lichtenstern, who grafted testes with the sectioned face on one of the obliquus minor muscles of the abdomen. In a later report Lichtenstern stated that in four other cases in which he placed the testicle in the scrotum, they either sloughed or became absorbed. In still further experiments Lichtenstern placed the testicle to be implanted on the scarified muscular tissue of the inguinal region. The conclusion that Lichtenstern reaches is: "Lydston's high percentage of cases in which the transplanted testicle sloughed was due to his method of implantation into the scrotum, the conditions there being far from favorable for vascularization as in a bed cut out for the graft in the fascia over the oblique muscle in the inguinal region, slightly scarifying the muscle."

Fig. 3. Testicle transplanted Voronoff method. Division of testis into four equal parts, epididymis removed.

Lissman did a subaponeurotic testicular graft but this graft absorbed more rapidly than Lissman expected.

Stanley and Kelker used, in three cases, Lydston's technic and in seven cases the implantations were grafted on the testes of the recipient.

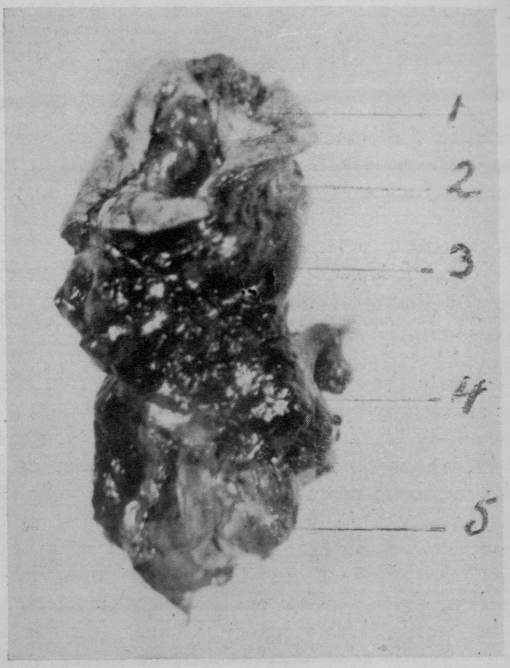

Fig. 4. A. G. (Case No. 11551). Successful transplant of testis of macacus nemestrinus into human. Essayist's method. (1) Skin; (2) subcutaneous tissue and fat; (3) muscrectus abdominis; (4) living transplant—testis; (5) peritoneum.

Fig. 5. A. G. (Case No. 11551). Unsuccessful transplant of testis of macacus nemestrinus into human. Lichtenstern's method. Transplanted same day as transplant by Essayist's method.

Enderlen uses as the site for implantation the rectus abdominalis muscles. Foerster used the fascia of the abdominal muscle. Mariotti placed the

graft subaponeurotically. Kreuter implanted one-half of the testicle between the *obliquus abdominis internus* and the fascia. Hammesfahr implanted into the abdominal musculature. Other observers have placed the testes underneath the pectoralis major. McKenna implanted it into the inguinal region and sutured the implant to the spermatic cord.

While, undoubtedly, a great many cases operated upon by the authors above mentioned have healed *per primam intentionem*, yet the fact remains that a large number of grafts suppurated and sloughed

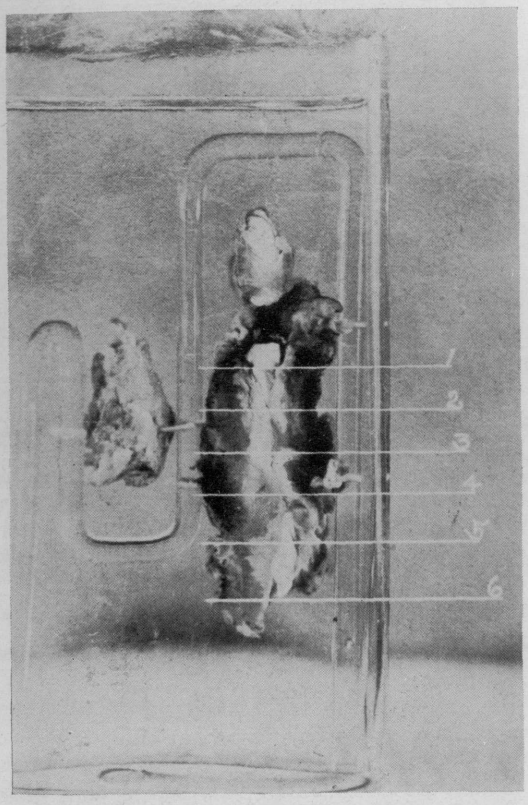

Fig. 6. Results of Lichtenstern's and Essayist's method of testicular transplantation.

Right: Four months after transplantation of testis of nemestrinus into human. (1) Skin and subcutis. (2) Skin subcutis and muscle. (3) Muscle and transplanted testis. (4) Same. (5 and 6) Transplant and peritoneum.

Left: Transplant according to Lichtenstern's method; same size; same patient; same date. Note comparative results.

according to the statements of the various observers. I am inclined to believe that the site of implantation had a great deal to do with the suppuration in these cases. Keeping in mind the extreme delicacy of texture of the sex gland and its vulnerability to pressure, to which it is not subjected in its normal habitat, the thought projected itself upon me that a space where the implant may be placed without subjecting the delicate glandular structures to compression might, perhaps, prevent suppuration and pressure necrosis. A glance at the accompanying photographs (Figs. 4-5-6) illustrates the point in view.

Two testes were transplanted into the same individual for experimental purposes. One was placed

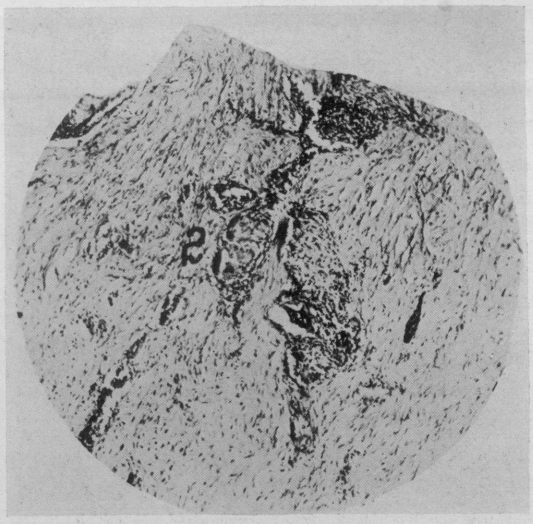

Fig. 7. Gross specimen Case No. 11551. (Slide No. 103.) Magnification 75 diameters. About four months after transplantation of testis of macacus nemestrinus, Lichtenstern's technic. (1) Rapid replacement of tubuli seminiferi by connective tissue. (2) Limited areas of interstitial islands.

Fig. 8. Gross specimen, Case No. 11551. Slide 103. Magnification 160 diameters. About four months after transplantation of testis of macacus nemestrinus. Lichtenstern's method. Note rapid replacement of tubuli by connective tissue and displacement of islands of interstitium.

entirely in accord with Lichtenstern's method and the other according to the method evolved by myself. The operation was performed on the same

individual at the same time, the glands weighing the same amount. After a given time both implants were removed and it was found that the gland transplanted by the Lichtenstern method had decreased remarkably in size, whereas the one implanted by my method was only slightly reduced in size. Pressure was responsible for the decrease in size in the specimen subjected to the Lichtenstern technic and the happy result in the other instance was due to placing the implant in an area calculated to be free from pressure. Microscopic examination of the Lichtenstern transplant showed all testicular elements to have vanished save small islets of interstitial cells (Figs. 7-8), while in the other specimen the usual manifestations observed in a transplanted testicle, such as seminal cell regression and interstitial cell proliferation, were to be seen in full activity. (Figs. 9-10-11.)

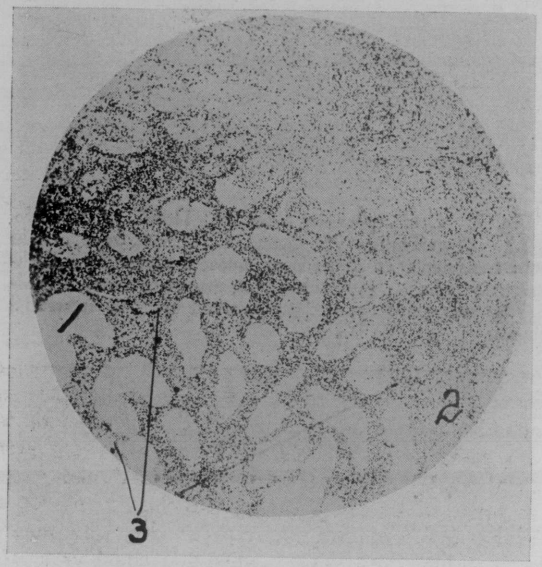

Fig. 9. Results with essayist's method of transplantation. Gross specimen Case No. 11551, slide No. 101. Magnification 60 diameters. About four months after transplantation of testicle of macacus nemestrinus. (1) Tubuli seminiferi in process of resolution. (2) Interstitium in process of hyperplasia. (3) New blood vessels.

My experience in operating by the Lichtenstern and other technics were discouraging; most of the implants being either too rapidly absorbed if healing *per primam* was the case, or suppuration ensuing, as was the case in the autotransplantation practiced by Lydston upon himself and others. This clearly illustrates the necessity of implantation in localities free from pressure.

After a great deal of experiment a *site was found by myself to be ideal for implantation and that is the supraperitoneal space with its mobile and free areolar tissue forming the base upon which the implant rests, it being gently secured in its position by slight pressure exerted from above by the rectus abdominalis muscle. The "give" of the loose peritoneum prevents any pressure upon the implant by reason of the contraction of the abdominal muscles or from other extrinsic causes.*

As will be seen, with the other methods pressure is not eliminated and in scrotal implantation there

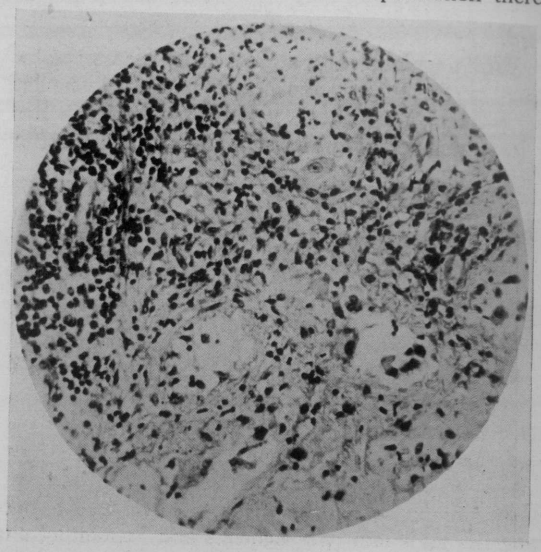

Fig. 10. Results with essayist's method of transplantation. Gross specimen, case No. 11551; slide No. 102. Magnification 225 diameters. About four months after transplantation of testicle of macacus nemestrinus. Essayist's method—showing giant cells; macrophages; Leydig cells; metamorphosed interstitium.

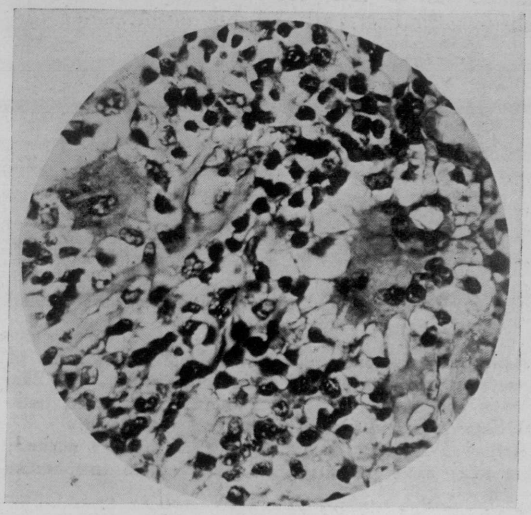

Fig. 11. Results of essayist's method of transplantation. Same section as the preceding, magnified 560 diameters.

is the added discomfort due to the mobility of the scrotum to contend with, which subjects the implants to more or less trauma from extrinsic sources. In implanting supraperitoneally, as practised by myself, freedom from pressure is at once obtained and aside from the occasional oozing of some sero-

sanguinous fluid there should at no time be suppuration if the technic has been aseptic and thorough. In a series of a considerable number of cases at my hands this statement has been amply verified.

Another important factor as to site is the vascularity of the surrounding tissues. The tunica vaginalis, as is well known, has a rather meager blood supply. The vascularity of the tunica albuginea if not denuded so as to expose the tunica vasculosa is also poor in blood supply. The site, therefore, that I selected is better adapted to receive the implant, for the peritoneum is very vascular and rich in blood and lymph spaces in the vicinity of the deep epigastric vessels and these supply a pabulum which is most ideal for blood and lymph circulation about the transplant.

D. Quantity of Gland Necessary for Implantation.

Some observers have used the entire testicle and its epididymis; others have "halved" it; still others have used only the body of the testis and discarded the epididymis. Voronoff splits the entire testis into four or six segments and implants all of them. Occasionally he modifies his technic by merely splitting the testis into two segments and implanting one or both halves as need be. Still another group of operators use variable sections ranging from 1 mm. to larger portions of tissue. There are, of course, occasional extremes met with as to the quantity of tissue used for implants. In 1913 Lespinasse transplanted into a man for the relief of impotence "slices" of testicular tissue 1 mm. in thickness!

Essayist's Experiments.

The possibility of grafting in the fashion of Lespinasse stimulated the writer to undertake some experimental studies to ascertain the fate of such grafts. These experiments were carried out as follows: On August 25, 1921, homotransplantation was practiced on a group of six monkeys (macacus rhesus). While it was difficult to cut slices 1 mm. thick we were able to get some thicker slices and deposited them between the rectus abdominis muscle fibers as suggested by Lespinasse. The first examination of the implant was made two weeks after the implantation and the others were studied three, four, five and six weeks after grafting respectively. *Microscopic examination revealed that at the end of two weeks the implants were well on their way to absorption, and that at the end of the twenty-fourth day not a vestige of the implant could be found, while in others the implant or suggestions of one could be found as late as the fourth week and none thereafter.*

The conclusions arrived at from these experiments justify the establishment of the fact that hormone production in animals transplanted by the Lespinasse technic can only continue as long as the Leydig cells persist, which in our experimental animals was *not longer than two to four weeks!* I repeated these experiments on two men with practically identical results. It is difficult for me to reconcile the splendid result reported by Lespinasse in his particular case with the microscopic findings in my series of experiments.

The rule I have adopted in transplantation is: 1. *If the donor is a young man in good health closely related to the recipient, and who of his own free will, and with a full understanding of the conditions, is willing to part with a portion of his testicle, approximately one-half of the testicle is excised, reconstructed and implanted into the recipient with a reconstruction of the remaining one-half of the donor.*

2. *If the testis is taken from a dead person or from the higher apes the entire testicle should be used for transplantation according to my technic which will be described forthwith.*

Technic No. 1.

(A) *Anesthesia:*

Those of us who are engaged in the transplantation of organs of internal secretion from the higher apes to humans for experimental or therapeutic purposes, will frequently meet with numerous obstacles which the essayist had to cope with and was able to surmount by meticulous attention to the general rules of asepsis coupled with painstaking regard for every detail. In the first place, the transportation of animals from their cages to the anesthetizing room presented some difficulty. A special anesthesia chamber was therefore constructed which eliminates a great many drawbacks with which the operator so often is confronted. My anesthesia chamber is so constructed that it can be attached to the door of the cage, as shown in Fig. 12. The arrow points to a sliding door which, when the chamber is attached to the cage door, is lifted up and the animal permitted to enter. As soon as this is accomplished, the sliding door is permitted to drop and from that moment on the animal is under absolute control and the anesthesia can proceed without any further trouble. There is an observation window in the anesthesia chamber (1) which permits the anesthetist to observe the actions and the general condition of the animal at all times; (2) indicates the aperture in the anesthesia chamber through which the anesthetic (usually ether) is permitted to enter; (3) is a screened window which permits the ingress of air. As soon as the anesthesia is commenced a glass door (4) is closed tight to intensify the effects of the ether. This can be opened at the pleasure of the anesthetist to permit entrance of air.

Fig. 13 depicts to better advantage the aperture through which the anesthetic is introduced. This can best be accomplished by either plugging the aperture with absorbent cotton and permitting the

anesthetic to drop from its container on this plug or a funnel may be introduced into it which is covered with an absorbent cotton floor.

Fig. 14 illustrates the upright position of the anesthetizing chamber during the administration of the anesthetic. A to-and-fro motion of the chamber will indicate to the anesthetist whether the animal is completely under the influence of the anesthetic or not.

As previously stated, the author prefers ether for general anesthetic purposes, as his experiences with chloroform have not been as satisfactory as with this agent.

(B) *Preparation of donor and recipient*:

The recipient should be prepared surgically, the site of implantation selected and rendered aseptic. The anesthetic used for the recipient is scopolamin-morphin supplemented by gas oxygen or ether, or one may use, if he so desires, local anesthesia throughout the entire procedure. If the material to be implanted is a refrigerated specimen the implant is kept in the container until the time it is to be transplanted. The setting up of the operating room with the relative positions of the donor and recipient are depicted in Fig. 15. Of course, two anesthetists are necessary, one for the donor and one for the recipient. The donor, if human, is prepared at the same time as the recipient; if an animal, it is shaved and rendered surgically aseptic after complete anesthesia has been induced. It is

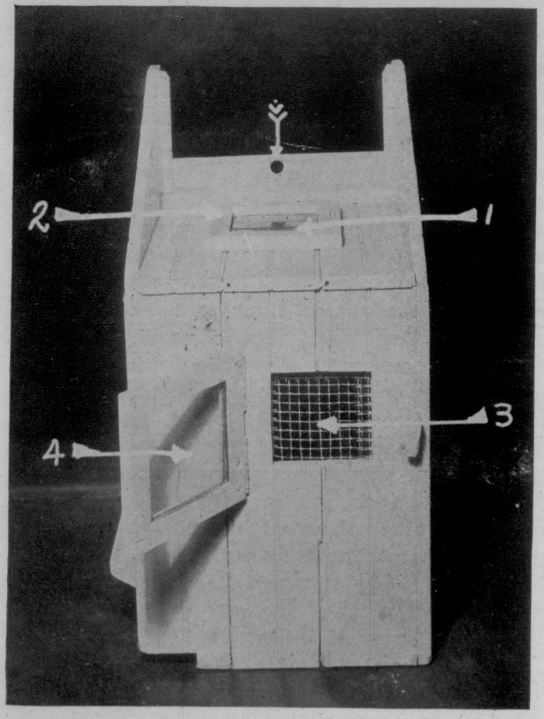

Fig. 12. Thorek special anesthesia chamber.

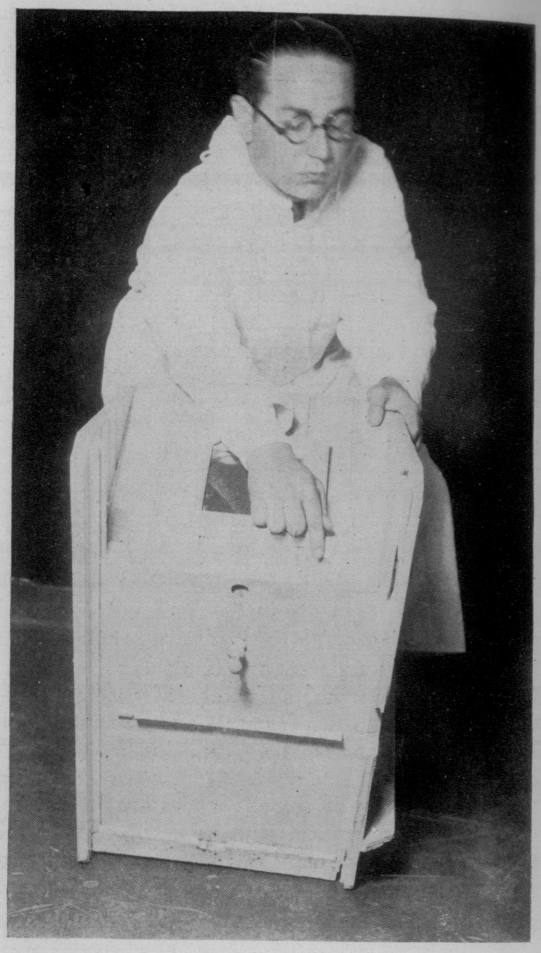

Fig. 13. Aperture in anesthetizing chamber.

then draped and brought into the operating room for ablation of the testis and the recipient, after complete relaxation has set in following anesthesia, has the area prepared for the reception of the implant. If the essayist's technic No. 1 is decided upon (the space for the reception of the implant being between the peritoneum and rectus abdominis muscle in the region of the deep epigastric vessels) this area is exposed by dissection through a Battle-Kammerer incision, keeping in mind that hemostasis is of the utmost importance. The space is prepared as shown in Fig. 16. Next pack the bed so prepared with a dry gauze tampon and proceed to ablate the testis that is to be implanted, as shown in the accompanying illustration, Fig. 16a.

Immediately upon removal of the testis strip it from its tunica vaginalis testis, leaving the epididymis intact, and snip out small pieces of the tunica albuginea with sharp scissors curved on the flat, as shown in Fig. 17. The essayist calls this step "lanternizing" for the reason that small fenestrae are created as a result of snipping away portions of the tunica albuginea. The ablation of the tunica

Fig. 14. Position of anesthetizing chamber during anesthesia.

albuginea, as described, results in the protrusion of the testicular substance, as shown in Fig. 18.

In my earlier operations I removed larger strips of the tunica albuginea than I do at present. It was found that removal of the large strips permits too much eventration of the testicular substance, and contributes to too rapid absorption. If one desires to resort to the "lanternizing" method only small sections of the albuginea should be removed. I have recently abandoned, however, this method and

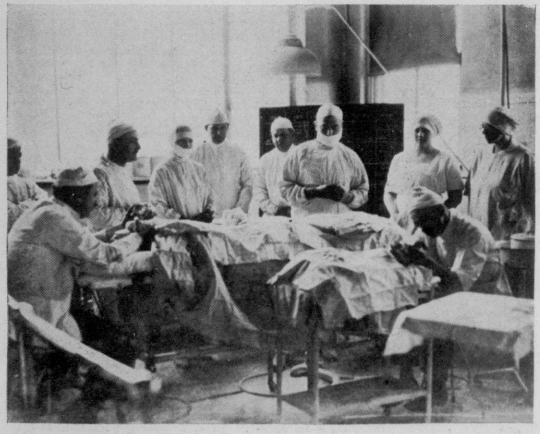

Fig. 15. Arrangement of operating room. (Thorek's technic of sex gland transplantation.)

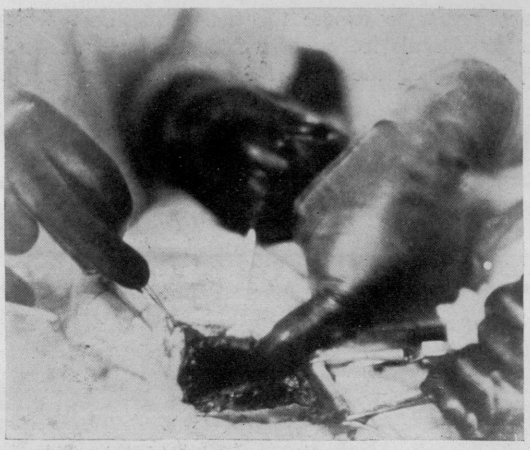

Fig. 16. Preparation of bed for reception of transplant. (1) Fascia of abdominal muscles; (2) rectus abdominis muscle; (3) bed between supraperitoneal structures and muscle.
(Thorek's technic No. 1.)

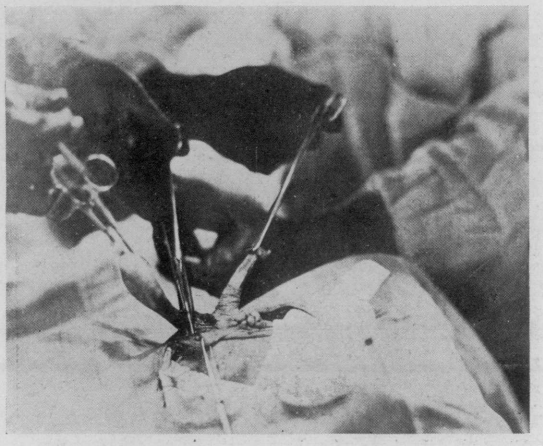

Fig. 16A. Dissection of parts of donor, in this instance a cynocephalus. Note removal of testis in its unopened tunica vaginalis and high amputation of funiculus spermaticus. (Thorek's technic No. 1.)

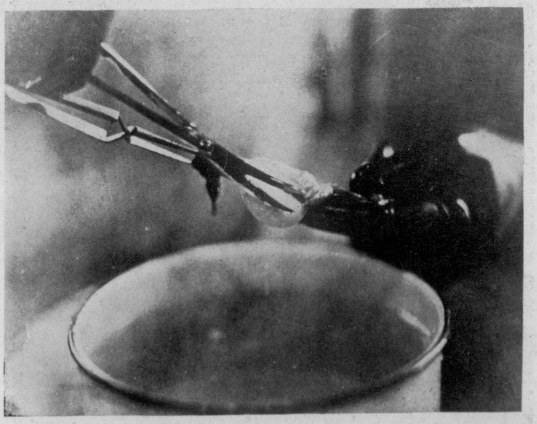

Fig. 17. Thorek's technic No. 1. Proper position of instruments and gland to obtain "lantern" denudation effect.

now prefer to expose the tunica vasculosa which is to vascularize with the contiguous structures by employing the electric thermocautery, Figs. 19

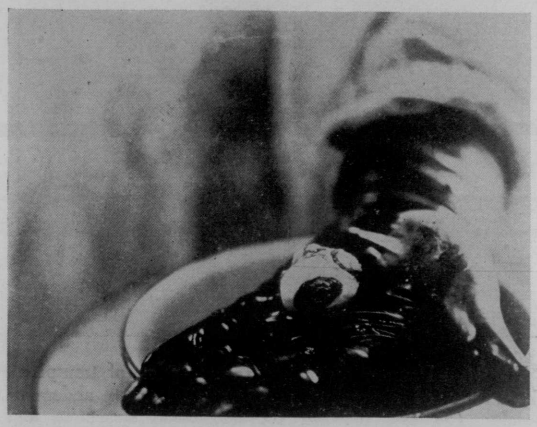

Fig. 18. "Lantern" denudation completed. (Thorek's technic No. 1.)

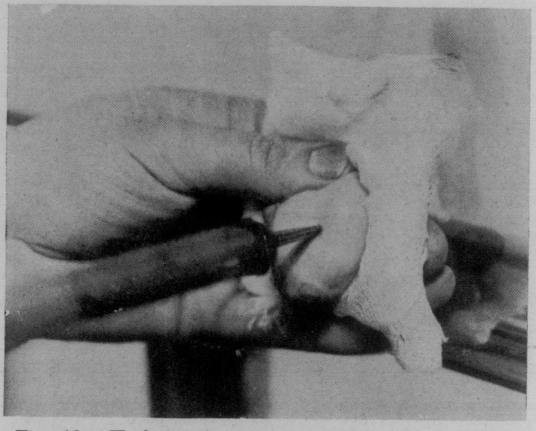

Fig. 19. Technic of using electro-thermo-cautery to expose tunica vasculosa. (Thorek's technic No. 1.)

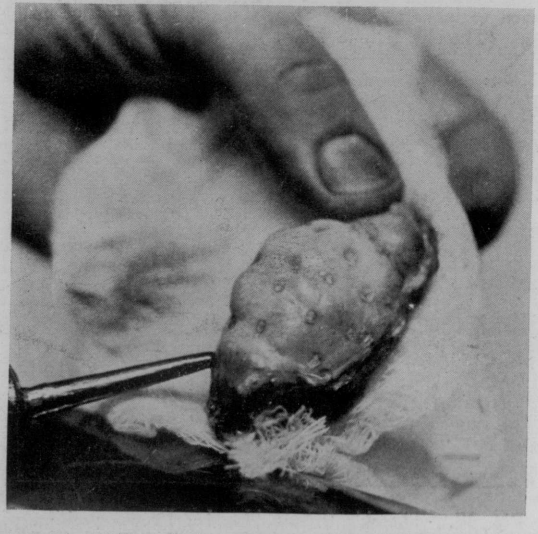

Fig. 19-A. Same as preceding.

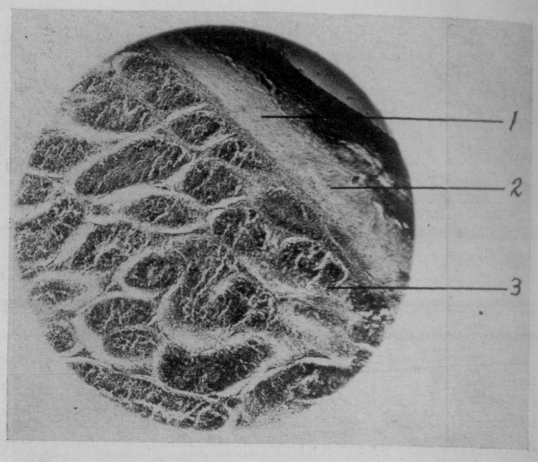

Fig. 20. Microphotograph. Showing degree of destruction of tunica albuginea with electro-thermo-cautery in exposing tunica vasculosa (proper method). (Thorek's technic No. 1.)
1—Normal tunica albuginea.
2—Swollen albuginea, the result of heating.
3—Tubuli seminiferi slightly affected by heat.

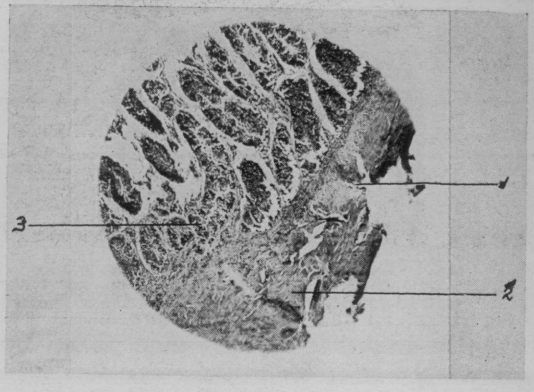

Fig. 20-A. Microphotograph showing excessive destruction of albuginea (improper method).
1—Ruptured albuginea.
2—Destroyed albuginea.
3—Thermal destruction of tubuli seminiferi.

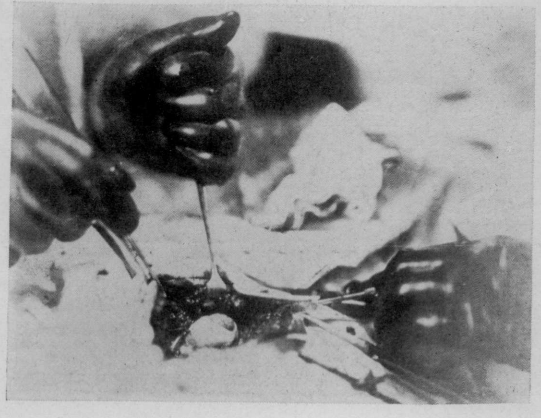

Fig. 21. Introduction of denuded transplant into bed previously prepared. (Thorek's technic No. 1.)

and 19A. During this procedure great care is necessary not to permit the penetration of the heated cautery point to too great a depth. It must be remembered that the object is the destruction of small areas of tunica albuginea and exposure of the tunica vasculosa sufficiently to cause union of the vascular and lymph elements between it and the contiguous anatomic structures whose function it will be to nourish and keep the implant alive. The accompanying micro-photographs (Figs. 20 and 20-A) show to what depth the tunica albuginea should be penetrated.

After preparing the implant by lanternization or cauterization it is deposited in the bed previously prepared for its reception in the depth of the abdominal wall, Fig. 21.

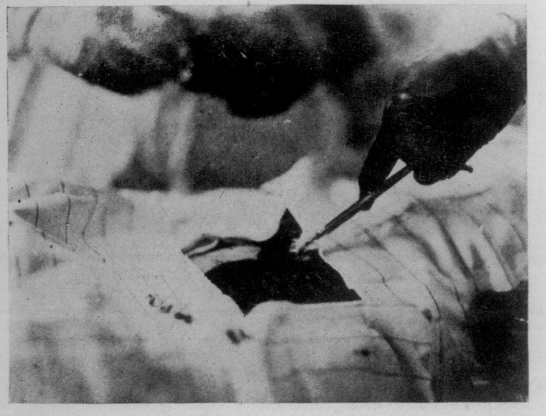

Fig. 22. Final sterilization of the skin with tr. of iodin or saturated solution of picric acid in alcohol. (Thorek's technic No. 1.)

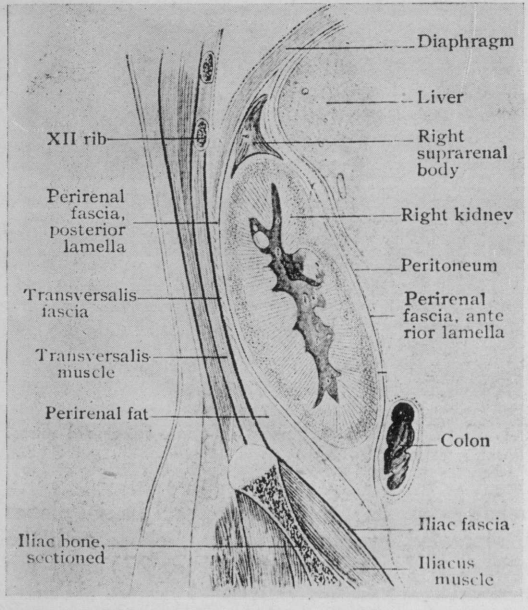

Fig. 23. Schematic longitudinal section showing relations of supporting tissues to right kidney (Gerota).

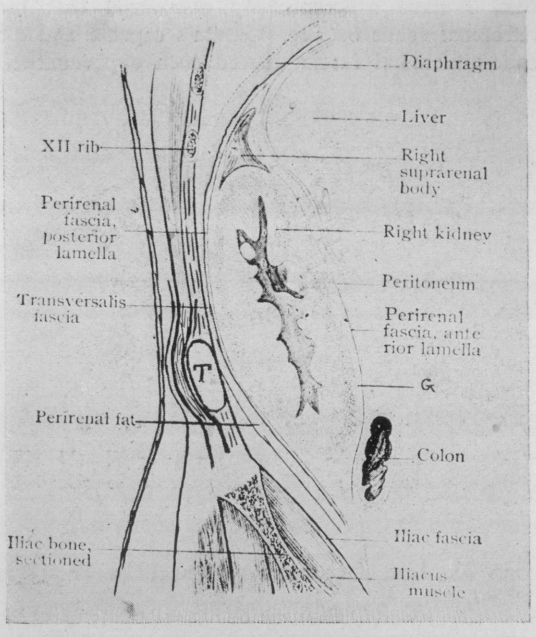

Fig. 24. Schematic longitudinal section showing position of transplant to surrounding structures.
T. Transplant.
G. Gerota's capsule.

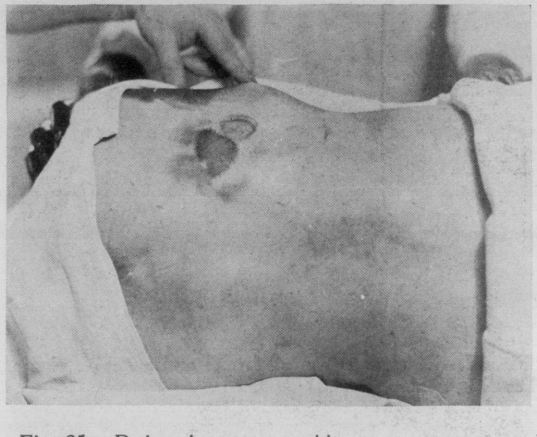

Fig. 25. Patient in proper position to expose retrorenal space. (Thorek's technic No. 2.)

The important point to be kept in mind at this stage of the operation is to have the operative field dry and free from blood. The rectus abdominis is now permitted to resume its normal anatomic relation, its fascia is closed with interrupted catgut sutures and the skin united with silk-worm gut, dermal sutures, or skin clips, as the operator may select. A coat of iodin is applied to the wound, (Fig. 22), which is then covered with a gauze pad and the patient is returned to bed.

Essayist's Technic No. 2.

To still further improve the technic by placing the implant in the most favorable position for func-

tion, I have experimentally discovered that the retrorenal space between Gerota's capsule and the endo-abdominal fascia offered such opportunities.

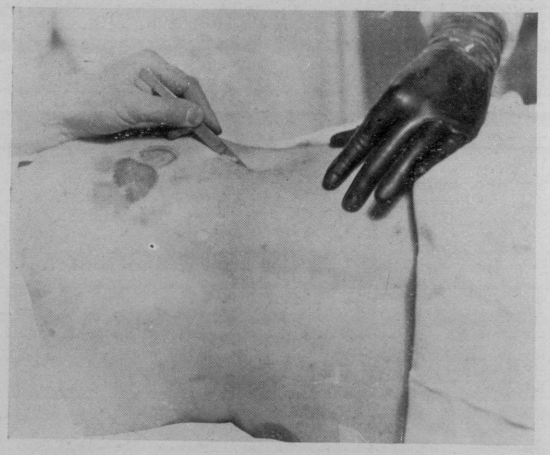

Fig. 26. Line of cutaneous incision. (Thorek's technic No. 2.)

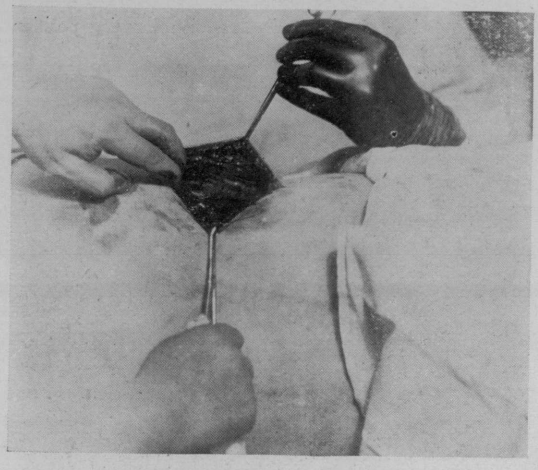

Fig. 27. Blunt dissection of fascial and muscular planes. (Thorek's technic No. 2.)

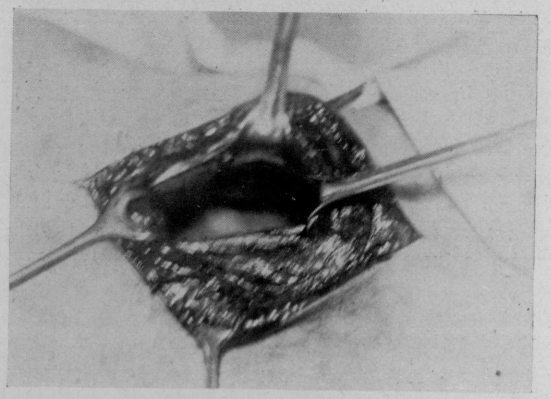

Fig. 28. Exposure of retrorenal space displaying Gerota's capsule and perirenal fat cushion.

The accompanying drawings nicely illustrate this space (Figs. 23 and 24).

In using this technic, which I designate as No. 2, the patient is placed in the position usually employed for kidney exposure (Fig. 25). An incision about two inches long, or longer if the patient is obese,

Fig. 29. Cauterization of tunica albuginea to expose tunica vasculosa. (Thorek's technic.)

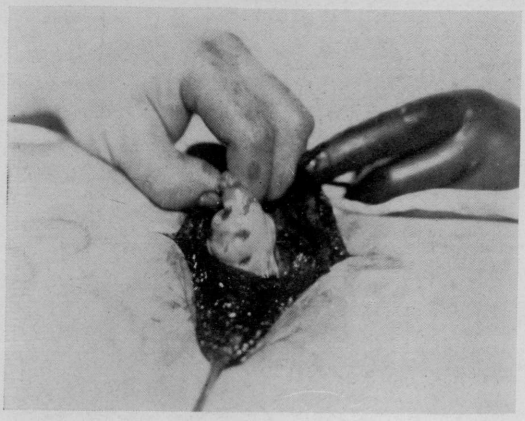

Fig. 30. Depositing cauterized testis into retrorenal space. (Thorek's technic No. 2.)

is made (Fig. 26), the muscular and fascial planes are separated by blunt dissection, either with the finger or a blunt instrument (Fig. 27) and the retrorenal space is then exposed, bringing into view Gerota's capsule and the perirenal fat cushion (Fig. 28).

The testicle to be implanted is then treated as described in my technic No. 1 (Fig. 29) and is then deposited loosely, without any sutures whatever in the retrorenal space (Fig. 30). Figure 31 shows the testis resting freely in this space, entirely unsubjected to pressure. Two or three catgut su-

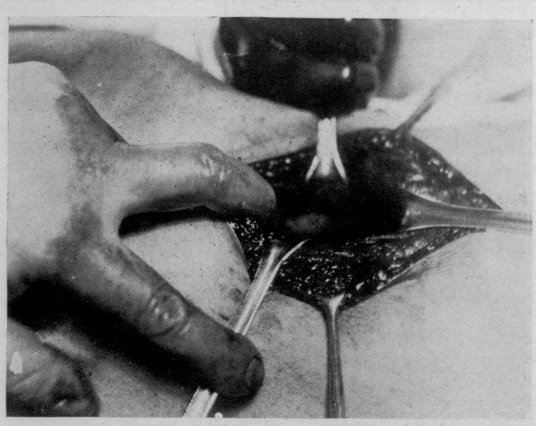

Fig. 31. Testis resting in retrorenal space free from pressure. (Thorek's technic No. 2.)

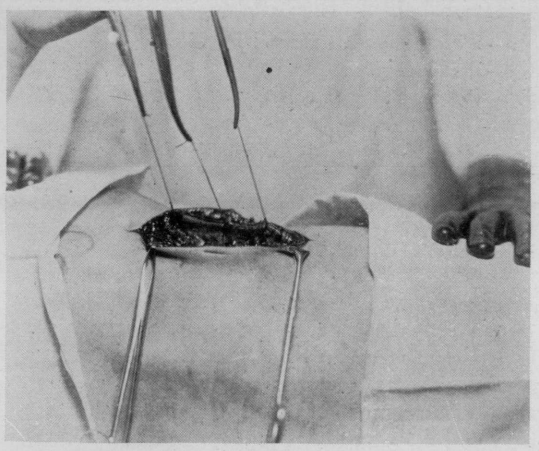

Fig. 32. Catgut sutures uniting lumbar muscles and fascia. (Thorek's technic No. 2.)

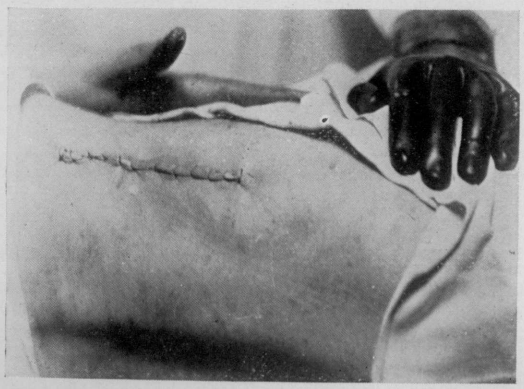

Fig. 33. Skin closure. (Thorek's technic No. 2.)

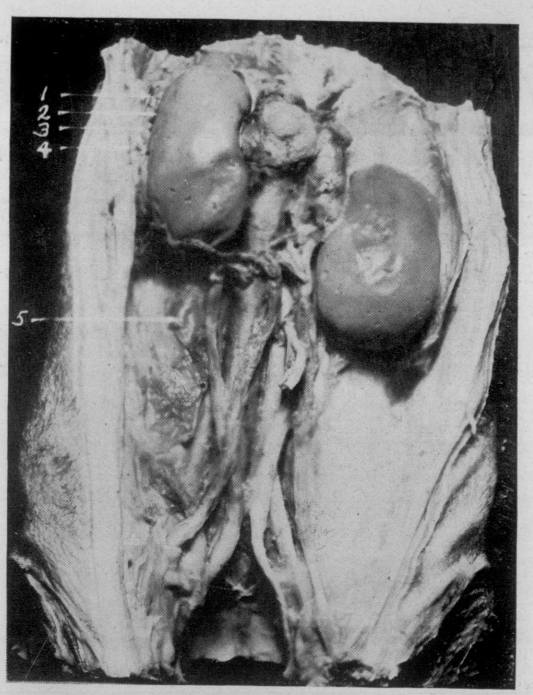

Fig. 34. Thorek technique No. 2.
1—Gerota's capsule.
2—Fibrous capsule.
3—Perirenal fatty capsule.
4—Peritoneum.
5—Transplant vascularized by the third lumbar vessels. Transplant is situated subperitoneally in fat between the peritoneum and the fascia.

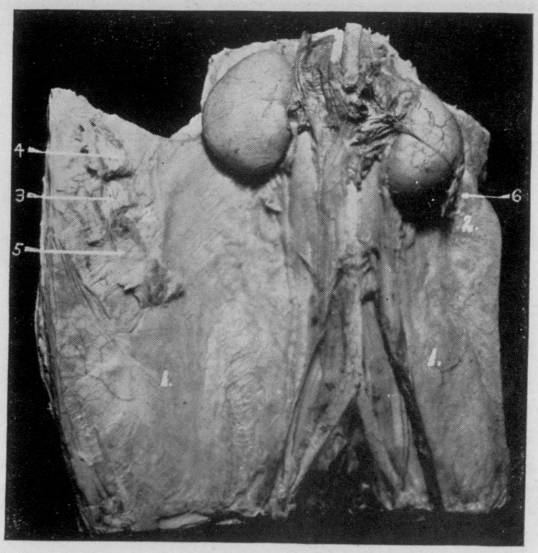

Fig. 35. Thorek technique No. 1 and No. 2.
1—Peritoneum.
2—Peritoneum cut away exposing muscle.
3—Transplant situated in anterior abdominal wall.
4—Sagittal section reflected upward.
5—Section reflected downward.
6—Transplant by technique No. 2 posterior to left kidney. The anterior transplant is vascularized through the inferior and superior epigastric vessels.

tures (Fig. 32) unite the superimposed muscles and fascia and the skin is closed with dermal sutures (Fig. 33) linen, silkworm gut or clips, according to the fancy of the operator.

The accompanying photographs show (Figs. 34 to 37 inclusive) some of the results of the animal experiments which led up to the evolution of my technic No. 2. Study of these pictures affords conclusive proof of the vascularization of the transplant through the lumbar vessels.

In Figs. 35 and 36 comparative results are shown between my technics No. 1 and No. 2, and

Fig. 36. Thorek technique No. 1 and No. 2.
1—Fibrous capsule of left kidney.
2—Perirenal fatty capsule.
3—Gerota's capsule.
4—Sagittal section reflected upward and secured by thread.
5—Transplant situated posterior to left kidney.
6—Blood vessels of lumbar origin.

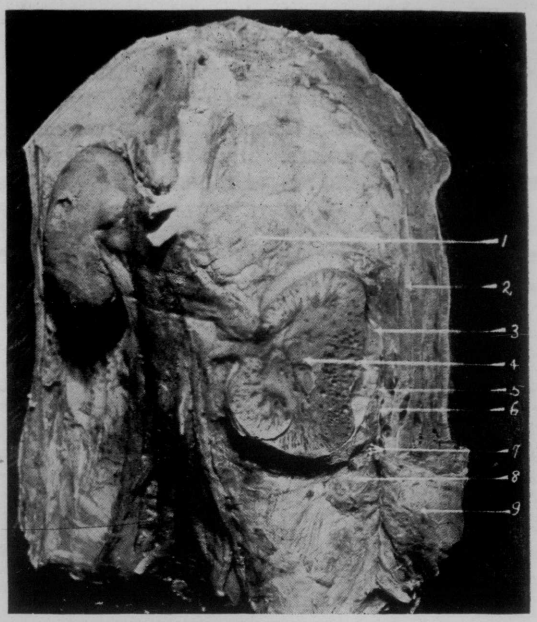

Fig. 37. Thorek technique No. 2.
1—Adrenal gland.
2—Peritoneum.
3—Fibrous capsule separated from kidney.
4—Left kidney.
5—Perirenal fatty capsule.
6—Gerota's capsule.
7—New blood vessels originating from third lumbar vessels.
8—Transplant situated subperitoneally and beneath fascia.
9—Flap reflected outward consisting of peritoneum and subperitoneal fat.

in Fig. 37 we find a human testis transplanted into a cynocephalus, which became thoroughly vascularized accompanied by the usual reduction in size.

All of these transplants were examined approximately three months after transplantation.

The following tables give the author's clinical results of 97 transplantations from 1919-1923 inclusive.

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RESULTS OF NINETY-SEVEN TESTICULAR TRANSPLANTS OBSERVED OVER A FOUR-YEAR PERIOD (1919-1923)

No. of Cases	*Type of Cases*	*Type of Transplant*	*Results for Both Types of Transplants*
69 (A)	*Senility*, physiological and precocious, representing all degrees of clinical manifestations, including the male climacterium and chronic constitutional diseases.	29 homotransplants 40 heterotransplants	31 symptomatic restorations to normal. 13 markedly improved. 12 slightly improved. 13 failures.
11 (B)	*Loss of testes* from trauma, tuberculosis, sarcoma or suppuration of various types.	3 homotransplants 8 heterotransplants	8 markedly improved. 3 failures.
8 (C)	*Neurasthenia* gravis: sexual neurasthenia; impotency at early age not due to organic diseases.	3 homotransplants 5 heterotransplants	5 markedly improved. 3 failures.
5 (D)	*Dementia precox* 3 Other psychoses 2	1 homotransplant 4 heterotransplants	2 markedly improved. 2 failures. 1 slightly improved.
2 (E) 1 1	*Glandular syndrome*, Fröhlich's disease. Eunuchoidism. Hypogenitalism.	all heterotransplants	1 slightly improved. 3 failures.

RESULTS OF NINETY-SEVEN TESTICULAR TRANSPLANTS OBSERVED OVER A FOUR-YEAR PERIOD (1919-1923)

Results	*Group A* Senile Atrophy		*Group B* Trauma and Pathology		*Group C* Functional Disorders		*Group D* Psychoses		*Group E* Glandular Syndromes		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Complete symptomatic recovery	31	45.0	0	0	0	0	0	0	0	0	31	32.0
Marked improvement	13	18.8	8	72.7	5	62.5	2	40	1	25	29	30.0
Slight improvement	12	17.4	0	0	0	0	1	20	0	0	13	13.4
Failures	13	18.8	3	27.3	3	37.5	2	40	3	75	24	24.6
Total cases	69	100	11	100	8	100	5	100	4	100	97	100
Type of Transplant												
Homo-	29		3		3		1		0		36	
Hetero-	40		8		5		4		4		61	

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