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Human Renal Homotransplantation. New Surgical Technique

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Summary

Complications of surgical aspect and which may occur after renal homotransplantation following the classical techniques in the vascular anastomosis as well as in the reestablishment of the continuity of the urinary excretory tract, and which jeopardize the future of a transplanted kidney are analysed.

The authors describe the technique followed in a series of cases consisting of the conservation *in totum* of the receiver's excretory tract (ureter and renal pelvis) performing a pyelo-pyelic anastomosis. No urinary drainage has been used, no catheters, either ureteral or urethral. No urinary complications were observed of the fistulas, stricture, urinary infection, extravasation, anastomosis dehiscence or ureteral reflux type. Complications of the graft excretory tract of immunological type are thus avoided. The technique to be followed in cases of anomalies in the excretory tract of the donor are also described.

Concerning the vascular chapter, instead of the classic reno-iliac venous anastomosis, they perform the reno-cava anastomosis of easier execution which provides a better return circulation and moreover situates the kidney in a better position. They prefer the right kidney particularly if it proceeds from a cadaver. Whichever kidney selected, they situate it in an inverted right lumbo-iliac position. The same method applies for the homotransplantation of an adult kidney to a child. According to the results obtained with this new operating method submitted, a major safety is obtained with better functional results thus allowing the attainment of optima hemo and urodynamic conditions in the renal homotransplantation while eliminating the postoperative complications which frequently occur when using the traditional techniques which are the cause of immediate surgical failures and of tardy complications of the renal homotransplant.

Zusammenfassung

Nierenhomotransplantation beim Menschen. Neue chirurgische Technik

Komplikationen in chirurgischer Hinsicht, die nach der Transplantation bei der klassischen Technik an den Gefässanastomosen und bei der Wiederherstellung der Kontinuität des Harnausscheidungstraktes auftreten und die die Zukunft der transplantierten Niere gefährden, werden analysiert.

Die Autoren beschreiben eine Technik, die bei einer Serie von Fällen angewandt wurde, wobei der Ausscheidungstrakt (Harnleiter und Nierenbecken) des Empfängers *in toto* erhalten wurde zur Durchführung einer Nierenbecken-Nierenbecken-Anastomose. Eine Harnableitung wurde nicht benutzt, keine Katheter, weder ein Ureter- noch ein Urethral-Katheter. Harnkomplikationen wie Fisteln, Strikturen, Harnwegsinfektion, Extravasat, Anastomosendehiscenz oder ureteraler Reflux wurden nicht beobachtet. Komplikationen immunbiologischer Art im Ausscheidungstrakt des Transplantates werden so vermieden. Die zu befolgende Technik bei Fällen von Anomalien des Ausscheidungstraktes des Spenders werden ebenfalls angegeben.

Was das Gefäßkapitel angeht, so wurde an Stelle der klassischen Nieren-Iliacal-venenanastomose eine Nieren-Venen-Kavaanastomose angelegt, die leichter durchzuführen ist, einen besseren Blutrückfluss gestattet und ausserdem die Niere dadurch in eine bessere Position bringt. Sie bevorzugen die rechte Niere, besonders wenn sie von einer Leiche gewonnen wird. Welche Niere auch ausgewählt wird, sie betten sie in eine gedrehte rechte Lumbo-Iliacallage. Die gleiche Methode ist für die Homotransplantation der Erwachsenen- und Kinderniere auf ein Kind anwendbar. Nach den Ergebnissen, die mit dieser Operationsmethode erreicht wurden, wird eine grössere Sicherheit mit besseren funktionellen Ergebnissen erreicht. Dadurch werden optimale haemodynamische und urodynamische Bedingungen in dem Nierentransplantat erreicht und postoperative Komplikationen, die häufig bei der traditionellen Technik auftreten, vermieden, welche die Ursache für sofortige chirurgische Misserfolge und für Spätkomplikationen des Nierenhomotransplantates sind.

Résumé

L'homotransplantation rénale chez l'homme. Nouvelle technique

L'auteur analyse les complications d'ordre chirurgical survenant à la suite d'une homotransplantation rénale faite selon les techniques usuelles d'anastomose vasculaire et de rétablissement de la continuité du tractus urinaire. Il souligne combien ces complications obèrent l'avenir du rein transplanté.

En réalisant dans une série de cas une anastomose pyélo-pyélique directe qui laisse intacts l'uretère et la bassinette du receveur, les auteurs pensent éviter les réactions de rejet à partir de ces tissus s'ils sont transplantés avec le rein. Sans utiliser de drainage d'aucune sorte ils n'observent ni fistule ni stricture ni infection, et aucun reflux vésico-urétéral.

Une anastomose veineuse réno-cave assure une meilleure circulation de retour et maintient le rein dans une meilleure position. La préférence est donnée à la greffe du rein droit mais, que le transplant soit de gauche ou de droite, il est toujours fixé en position renversée, lombo-iliaque droite. Même méthode pour la greffe d'un rein d'adulte à un enfant.

Ces modifications de technique ont permis d'obtenir un meilleur résultat hémodynamique, et d'éliminer les complications chirurgicales des homotransplantations rénales classiques.

Resúmen

Homotrasplante renal. Nueva técnica quirúrgica

Se enumeran las complicaciones de orden quirúrgico que pueden sobrevenir después de un homotrasplante renal siguiendo las técnicas clásicas en las anastomosis vascu-

lares y en particular en el restablecimiento de la continuidad de la vía excretora urinaria y que ponen en juego el futuro del riñón trasplantado. Describen los autores la técnica seguida en una serie de casos consistente en conservar toda la vía excretora del receptor (ureter y pelvis renal) practicando una anastomosis piel-pielica y sin utilizar cateteres de ningún tipo, no habiendo sido observado ninguna complicación del tipo: fistulas, infección urinaria, estenosis, dehiscencia o reflujo. En lo que concierne al capítulo vascular, en lugar de la anastomosis venosa reno-iliaca proceden sistemáticamente a la anastomosis reno-cava, de más fácil ejecución y que proporciona una mejor circulación de retorno. Prefieren el riñón derecho, particularmente si proviene de cadáver. Cualquiera que sea el riñón elegido lo sitúan en fosa iliaca derecha y siempre en posición invertida. El mismo método se aplica para la homotrasplanteación de un riñón de adulto a niño. De acuerdo con la experiencia de los autores estas directrices dan una mayor seguridad quirúrgica, permitiendo la consecución de óptimas condiciones hemo y urodinámicas en el homotrasplante renal eliminando las complicaciones postoperatorias que frecuentemente sobrevienen utilizando las técnicas hasta ahora conocidas y que son la causa de los fracasos inmediatos y alguna vez lejanos del homotrasplante renal.

Whoever considers that the surgical technique in renal transplantation is regulated and systematized is mistaken, and he who believes that only the immunological problem exists and that the surgical one is solved, is wrong. If we go over the statistics of the cases already published and investigate those not yet published, we shall realize that the majority of unsuccessful homotransplantations did not pass the surgical stage and this because of a faulty technique, of viability of the graft, of time, but in particular because of complications inherent to the technique used which offers very little for the safety required. Renal transplantation technical problems have been underestimated in the past, and in spite of the progress of surgical techniques, some homografts may be considered lost due to arterial, venous and ureteral obstruction, or to uretero-vesical anastomosis failures [KOLFF].

Immediate bad functioning of a viable graft is not due in the great majority of cases to immunological aggression, but to surgical errors placing the kidney in bad uro and hemodynamic conditions which are the cause of a high percentage of failures or deaths within the first two or three months. It is an evident fact that the transplanted kidney is more susceptible to infection and to these hemo and urodynamic alterations than the normal kidney.

The future of a renal transplant is closely related with the immediate operative result.

If renal function is satisfactorily reestablished during the actual operating act, the transplant has great possibilities of success in the

future, but if under the same conditions the transplantation fails, it is generally due to non-renal complications.

When a kidney does not function immediately, owing to surgical or viability reasons the possibilities of success are few. Although acute tubular necrosis lesions may appear thus requiring maintenance of the patient on dialysis, the rejection crisis occurring during this period of anuria will either pass undetected and unnoticed or be discovered too late causing lesions at the graft's level which will influence its future. On the other hand immunosuppressors' toxicity is proportionally inversed to renal functionalism.

Among the multiple aspects of the surgical uncertainties of renal homotransplantation two of them, the reestablishment of urinary continuity and the return circulation are the most important problems which may lead to immediate or late failure of the transplant. Late complications are also involved in the operative technique.

Reestablishment of the continuity of the graft's excretory tract. A study of the most recent statistics calls our attention to the high percentage of urinary complications in the way of: necrosis of the ureter, urinary fistula, ureteral reflux, stricture and in particular the persistent urinary infection, problems each one of difficult solution, and which jeopardize the patient's life.

Two surgical methods are in use to-day for renal transplantation concerning its excretory tract.

1. *Implantation of the ureter.* In different ways: direct anastomosis of the ureter with the bladder and muco-mucosa suture. Direct anastomosis of the ureter with the bladder, but burying the ureter in the vesical muscular layer. Implantation of the ureter following a submucous pathway before flowing into the vesical lumen.

2. *Uretero-ureteral anastomosis* of the ureter of the transplanted kidney with the receiver's with or without ureteral catheter. It should be emphasized that neither of these two methods offer an absolute normal excreto-urinary function.

Complications common to both procedures are as follows:

a) *Necrosis of the ureter.* Not very frequent, may be due to different causes; some vascular, others of immunological nature.

It is known that the ureter has a very peculiar vascularization. It is fed from an upper group supplied by the renal arteries or by

the capsule-adipose arteries and in most cases formed by two arteries originating from a bifurcation of the renal artery or from its trunk; from a middle group proceeding from the aorta above its bifurcation; from the ovarian, ureterine, spermatic or common iliac; from a lower group with one branch supplied by the vesical artery; and others by the spermatic or the uterine.

All these arteries form an anastomotic plexus of vessels along the ureter establishing the vascular union between the kidney and the bladder.

In the graft, the whole of the excretory tract is fed from the upper group alone, which in some cases is not sufficient to irrigate the most distal part of the ureter as we observed in one of our transplants with the consequent distal necrosis. Another cause of the insufficiency is due to anomalies of the superior ureteral pedicle such as originating directly at the aorta level, or from the capsule-adipose system, which owing to its small caliber cannot be anastomosed or is overlooked, especially if the kidney is taken from a cadaver when the identification for several reasons, is more difficult. It is also possible that during dissection manipulation and preparation of the renal artery this branch may pass unnoticed and become lesioned, especially when this ureteral artery originates directly from the renal trunk.

Cases of necrosis of the ureter have been reported one month after the grafting which can be caused by venous infarct due to ureter vein lesion, more so when anomalies are present jeopardizing its return circulation and consequently the ureter's viability.

However, the partial and late necrosis followed by urinary fistula some of which were noticed during the third or fourth month are of immunological type as these lesions have been histologically proved. Moreover they appeared immediately after the rejection crisis.

b) Ureteral reflux is due to lack of an efficient valvular mechanism which is not always obtained by reimplanting the ureter along a submucous pathway and still less by using direct implantation techniques. By itself the reflux promotes ascending pyelonephritis and late renal sclerosis.

It is obvious that by these techniques ureteral catheters are required, and even though for a few days only, its use conditions urinary infection, which in the specific case of renal grafting acquires considerable importance from several points of view.

c) *Ureteral stenosis*. Less frequent but more damaging than reflux for the transplanted kidney. It may appear in the uretero-vesical implantations as in the uretero-ureterals anastomosis but especially, in the latter as catgut must be employed in the suturing of this tract, and acting as a foreign body will create an inflammatory reaction process first, and a cicatricial retraction afterwards, which on account of the small caliber of the ureter, even with the bevelled ureterographies will constitute a mechanical hindrance.

d) *Urinary fistulae*. This is one of the most common complications especially in the uretero-ureteral anastomosis.

The physiopathological consequences of sectioning the ureter *in situ* followed by immediate suture, are known. MARION proved:

1. That neither the renal nor the vesical extremity were paralysed.
2. That the upper extremity contractions were detained at suture's level.
3. That the anarchical lower extremity contractions are produced out of time.

A physiological narrowing is established at suture's level even with good caliber and the urine is no more absorbed by the following segment but is detained and flows back, giving rise to a progressive dilatation occasioned by the pressure of accumulated urine forcing all along the suture line causing extravasation at the anastomotic level.

According to Kuss this anarchical urodynamic process leads to a transitory uretero-hydronephrosis lasting from three to five months, gradually subsiding until transmission is at last improved and reestablished.

In the case of a transplanted ureter this recuperation by *lack of vascularization innervation* and immunosuppressive treatment, may get involved by altering the process of cicatrization and even leading to stenosis of the anastomotic stoma.

Moreover, owing to the small caliber of the ureter, uretero-ureteral anastomosis suture will not always be watertight and there will be a consequent possibility of urine extravasation which, although not of transcendental significance in ordinary urological surgery, is of great importance in renal transplantation as it conditions infection of the retroperitoneal cellular space in a patient

with precarious defenses, and deficient cicatrization due to immunosuppressive therapy.

If the risk of a fistula is to be avoided a ureteral catheter will have to be used for a few days, the insertion of which will have to be carried out by endoscopic manipulations for its extraction or by opening the bladder by the uretero-vesical implantation methods. All this unfailingly leads to urinary infection, a menace to both, the transplanted kidney and the patient, but especially to the latter who may suffer an explosive evolution under the influence of the immunosuppressive treatment.

Septicemia caused by infection around the fistula has been cited as an important cause of mortality.

Several authors have observed typical histological rejection lesions at the excretory tract level of the transplanted kidney, which would explain the appearance of urinary fistulae coinciding with a rejection crisis.

Even in the case where none of these complications are present, the transplanted ureter cannot recover its normal peristaltism, and although it has its own nervous system represented by sub-adventitial ganglions it is necessary that by means of the ureteral nerves they be united to the common centers which coordinate and harmonize the total activity of the whole excretory tract. Transplantations performed using any of the described methods do not give absolutely normal urograms.

In order to avoid the aforementioned complications in 15 out of 20 patients who received a cadaver's kidney, and 5 patients with a living donor's kidney, we have used a procedure consisting of the conservation and utilization *in totum* of the whole of the receiver's excretory tract (renal pelvis and ureter). This naturally requires nephrectomy of the receiver's homolateral kidney. The entire ureter and approximately half of the pelvis are removed from the renal homograft, i.e., *the kidney alone is transplanted without its excretory tract*.

The receiver's renal pelvis is anastomosed to the graft's pelvis, thus obtaining an ample pyelo-pyelic anastomosis.

The utilization of the receiver's excretory tract, logically, requires a previous urographical exploration which is performed by suprapubic vesical puncture, contrast injection and the usual X-ray pictures enabling one to discard any active or passive vesico-renal reflux.

This principle involving the *in totum* utilization of the excretory tract responds to a physiological imperative requirement.

Ureteric musculature is a continuous system extending all along the urinary tract. It constitutes an anatomic and functional unit that must be integrally respected if a normal excretory dynamism has to be obtained from the beginning and with no ulterior complications.

The fragility of this system is an inherent factor of its own perfection; a slightest interruption, even temporary, of the nervous chain will upset the harmony and create anarchy [PAITRE].

In effect, we have observed that to preserve anatomically the whole of the receiver's excretory tract implies preserving its normal excretory-urinary physiologism. Anatomical integrity is tantamount to functional integrity.

Technique

Upon ligation of its vascular pedicle the receiver's homolateral kidney, still attached to its excretory tract, is exteriorized until reaching the iliac fossa where it is dissected and its renal pelvis carefully isolated including sometimes its intrasinusal portion by sectioning it as highest as possible (fig.3).

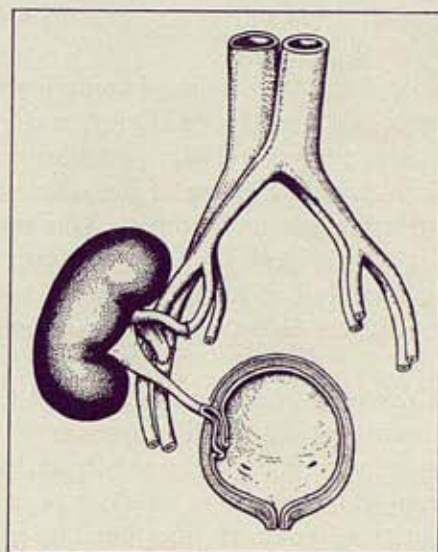


Fig. 1. Classical technique of human renal homotransplantation.

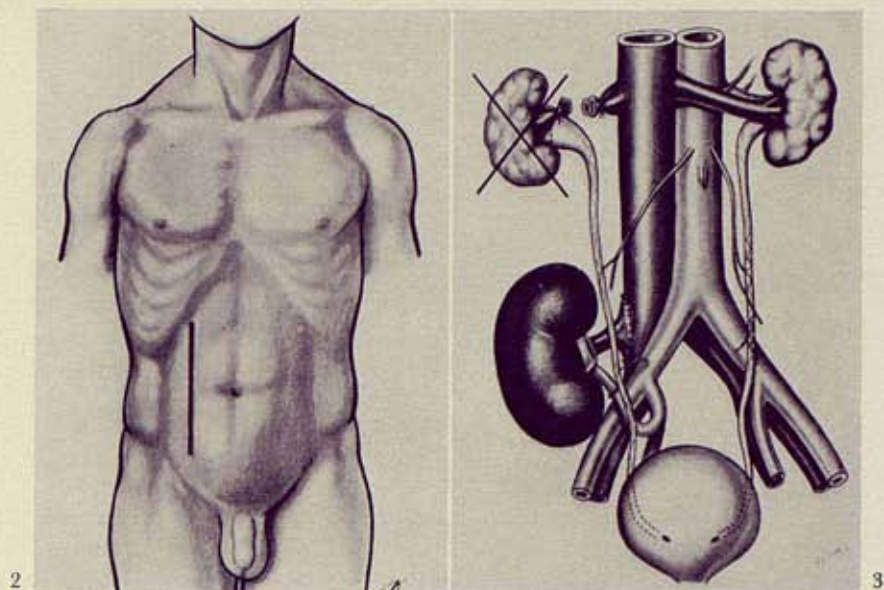


Fig. 2. Pararectal extraperitoneal incision for simultaneous renal homotransplantation and right nephrectomy.

Fig. 3. Our human renal homotransplantation technique. Reno-cava vascular anastomosis, lumbo-iliac renal position utilizing receiver's excretory tract.

The lumbar ureter is freed from its sliding sheath until reaching the point of entrance of the middle ureteral vasculo-nervous pedicle which must be respected.

The whole of the ureter and a large portion of its renal pelvis is resected from the graft in order to obtain a wide anastomotic opening. Those cases of intrarenal pelvis type offer no obstacle since the dissection and the posterior pyelo-pyelic anastomosis are intrasynusally carried out.

Both pelvises are confronted and their perimeters matched, the suture is continuous with very close stitches using an atraumatic needle with catgut 6/0 in one layer and avoiding ectropion of the mucosa (fig. 5). This suture must be very meticulous and care should be taken so that the edges meet perfectly. For this purpose magnifying glasses are required. The suture must be hermetic. *Of all the transplantation procedure this stage of the suturing requires the maximum attention and meticulous care on the part of the surgeon.*

By this technique no catheter either ureteral or urethral is used. Immediately after completion of the suture a correct and rhythmic functionalism of the excretory mechanism was observed and kept up indefinitely. The decapsulation of the kidney was carried out after the reestablishment of urinary continuity was completed. Only one tube is left for drainage of the lumbo-iliac fossa which is usually removed after 3 to 5 days. Upon awakening the patient urinates immediately through his natural ducts. Urograms obtained by this method were 100% normal.

Congenital anomalies of the organ to be transplanted. It is quite possible to come across anomalies of the excretory tract when using a cadaver's kidney, but this does not mean — as in a case of a double artery — to give up the transplantation.

In one of our cases the kidney to be transplanted presented a pyelo-ureteral duplicity

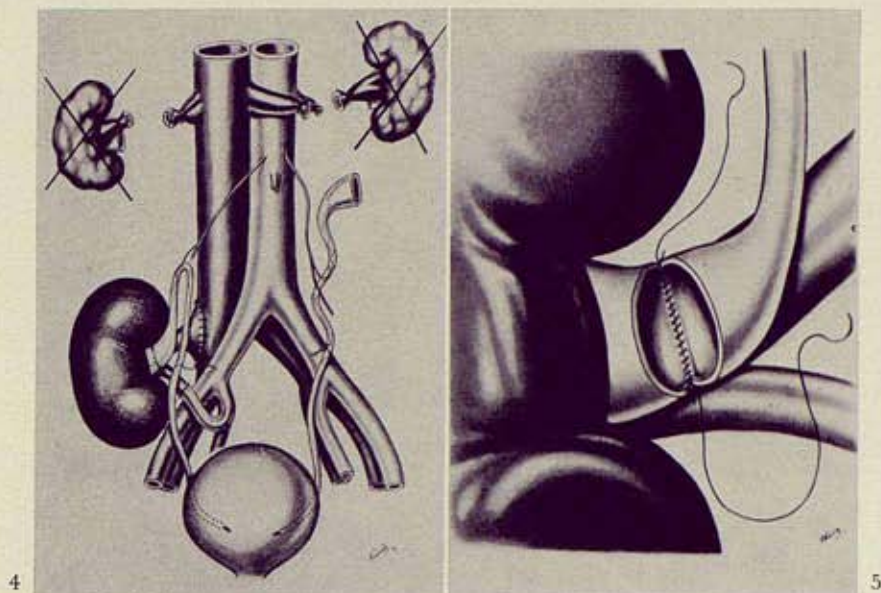


Fig. 4. Our human renal homotransplantation technique. Pyelo-pyelic anastomosis and simultaneous homolateral nephrectomy. The contralateral nephrectomy is performed if the kidney is infected.

Fig. 5. Detail of pyelo-pyelic anastomosis. Continuous suture in one layer with catgut 6/0 avoiding ectropion of the mucosa.

(fig. 11). The problem was solved according to the schematic drawing, by totally dissecting the intrarenal excretory tracts of the receiver's homolateral kidney. The two ureters of the graft were anastomosed to the major calices of the receiver's excretory tract without using ureteral catheters and by careful continuous suture with catgut 6/0 with the aid of magnifying glasses. No postoperative complications were present and the functional result is perfect (fig. 13).

When the pelvis of the graft is of intrarenal type the pyelo-pyelic anastomosis is intrasinusally performed with the aid of suitable retractors.

In one case of absence of renal pelvis in the receiver, due to extrarenal reunion of the big calices (schematic drawing of ureter duplicity) the whole of the receiver's excretory tract was preserved, calices included, and by their union a new pelvis was obtained. In one case in which a cadaver kidney was transplanted from a child to an adult, and owing to the disproportionate caliber between the graft's renal pelvis caliber and the receiver's caliber, we performed the graft's ureteropyelic union to one of the receiver's calices (fig. 19 and 20).

Complications

No stenosis were observed by this technique, a very comprehensible fact if we consider the ample anastomotic opening obtained.

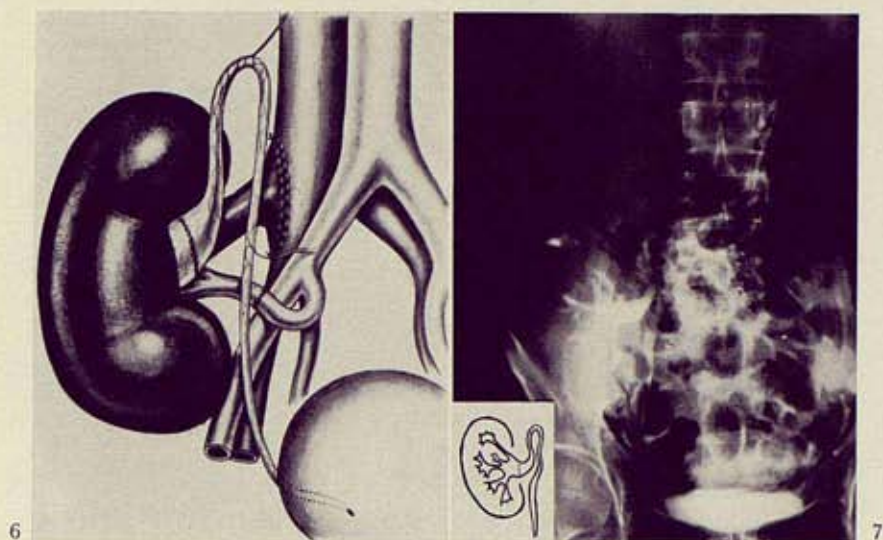


Fig. 6. Pyelo-pyelic anastomosis ended. At the level of its curve the ureter receives the medial vasculonervous pedicle.

Fig. 7. Intravenous urography one year after a renal homotransplantation. Ample pyelo-pyelic anastomotic opening and normal functionalism of the whole excretory tract.

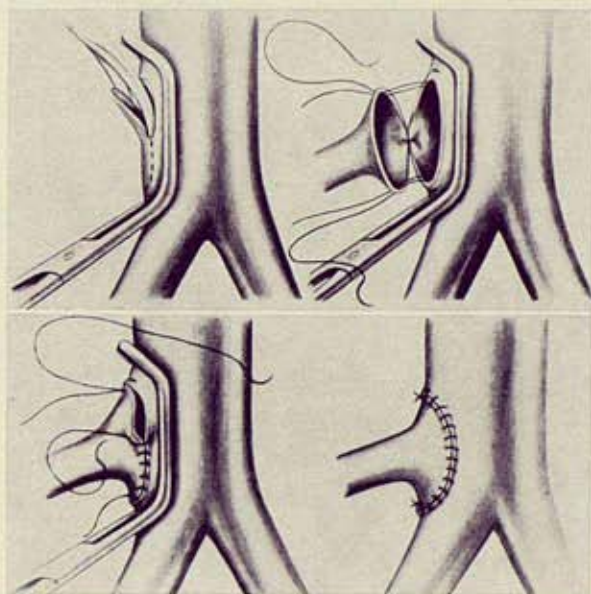


Fig. 8. Renal venous anastomosis with the lateral wall of the vena cava.

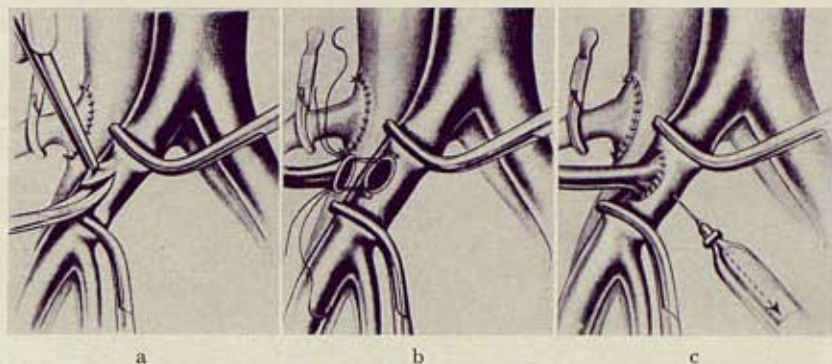


Fig. 9. Arterial anastomosis. a) excision in pastille of anterolateral wall of the primitive iliac artery. b) renoiliac end-to-side anastomosis. c) air aspiration to avoid gaseous embolia of the graft.

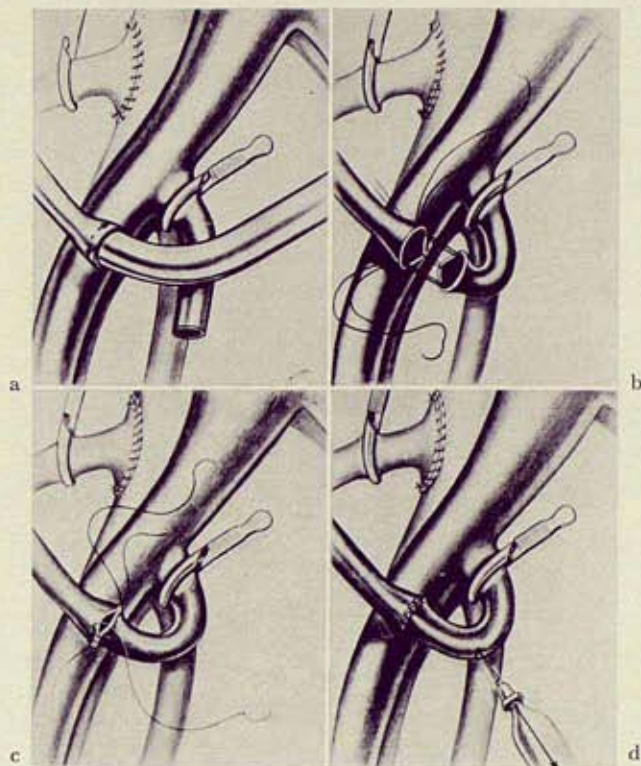
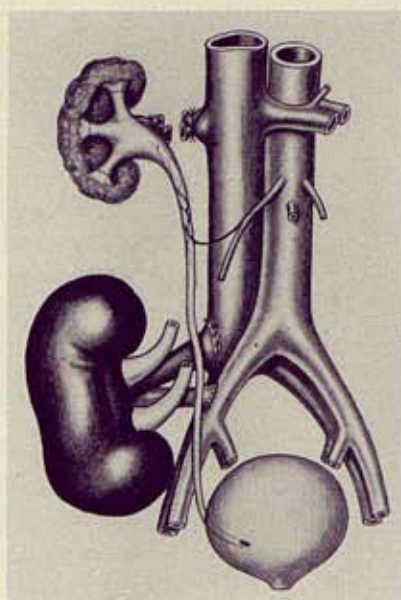
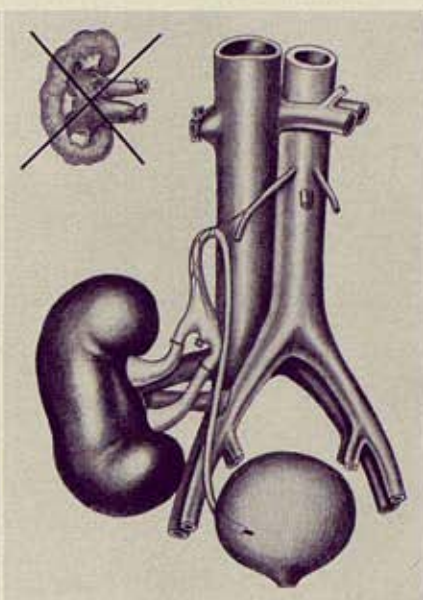


Fig. 10. Arterial anastomosis. a) renal artery extremity dilatation. b) end-to-end circular or elliptical anastomosis with internal iliac. c) continuous suture with Terylene 6/0. d) air aspiration from the interior of the vessel.



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Fig. 11. Transplantation of a kidney with double excretory tract. Right nephrectomy conserving ureter, pelvis and calices.

Fig. 12. Anastomosis of the ureters to both upper and lower calices, the middle calix was ligated.

No extravasation, no urinary fistulas immediate or remote. The prompt restoration of a normal peristaltism, as well as the functional permeability of the whole of the excretory tract explain well enough the absence of these complications. *Necrosis of the ureter or of the renal pelvis was not observed either.* Although the ureter is deprived of its superior pedicle it receives sufficient irrigation through the middle and lower pedicles, thanks to the peculiar longitudinal vascular anastomosis which runs along the whole duct.

One may ask: What should be done in the event of a fistula at an anastomosis pyelo-pyelic level? Although such a complication was never observed in practice and we consider it very remote – provided the technique is impeccable – one could proceed with an ample resection of the pyelic fistulous edges placing a new suture in one or two layers and inclusively leaving a ureteral catheter in place. It is logical to think that it would be easier to treat a pyelic fistula than a ureteral one.

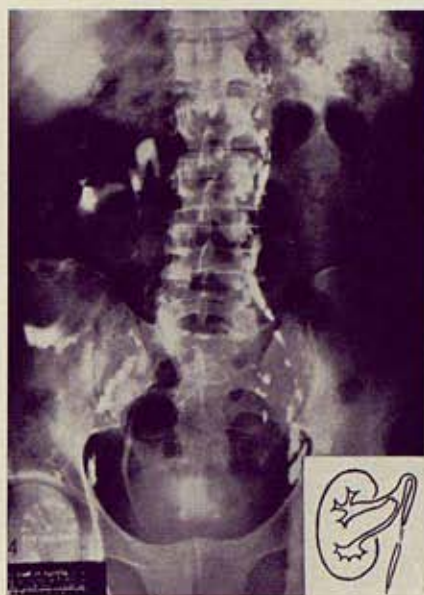


Fig. 13. U.I.V. 8 months after a homotransplantation with kidney taken from cadaver with pyeloureteral duplicity, corresponding to the previous two schematic drawings. Normal secretory and excretory functionalism.

Obviously the *absence of ureteral reflux* requires no explanation. An important fact to emphasize is the *absence of urinary infection*. By not employing any ureteral catheters the most important and determinant factor is abolished. Only in two cases an asymptomatic bacteriuria appeared, complication probably of the partial tubular necrosis due to initial or preexisting ischemia in the donor.

The absence of urinary and infectious complications in our transplanted patients who received a cadaver's kidney following this technique seems to discard the idea hitherto existing that such complications are due to intense immunosuppressive therapy by antimetabolites, corticosteroids or by X-ray action.

Nor does a 'local crisis' of rejection at the graft's level altering the cicatricial process at the anastomosis union seem to be the cause. We have witnessed very early and repeated crises without any local repercussion whatsoever. It has been mentioned that the source of the kidney could be an important factor which may cause the frequent appearance of urine extravasation at suture's level, being

more frequent in the kidneys taken from a cadaver. None of our patients presented a complication of this type.

Possibly a 'local crisis' of rejection at a certain level of the excretory tract of the graft with thrombosis of its small vessels and the consequent necrosis of some area of its wall is the cause of long-term fistulae appearance which, logically does not occur when the receiver's excretory tract is being utilized.

Even in the supposition that an 'immunological perforation' should take place in the remainder small pelvis of the graft, this would be of no consequence being situated in intrasinus situation and immediately covered by hilum elements, and by the parenchyma. *The impossibility of immunological complications at the graft's excretory tract level is another of the many important advantages of this method.*

By eliminating the graft's excretory tract and the pyelic fat the transplanted antigenic mass is considerably reduced.

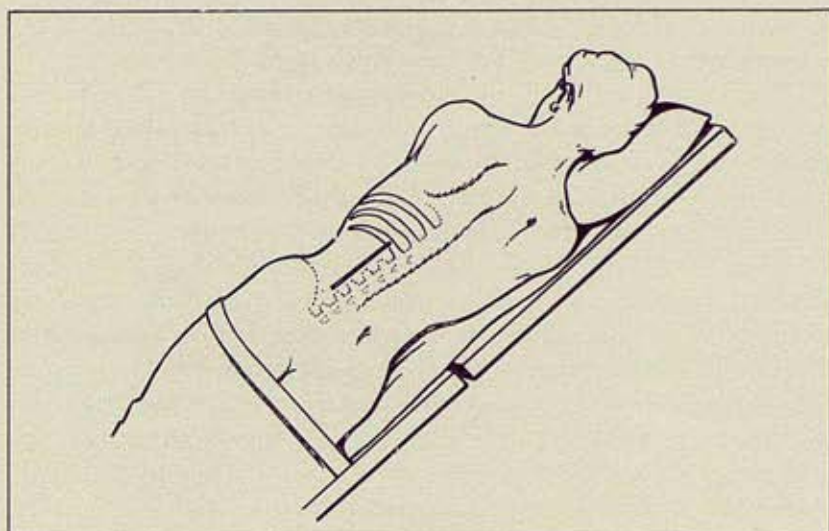
Vascular anastomosis. We reestablish the venous circulation in a different manner from the traditional end-to-side anastomosis of the renal vein with the external iliac (fig. 1).

This type of anastomosis which is routine in the renal homotransplantation offers some difficulties in its execution owing to the depth at which it is performed, and may create return circulation problems because the outlet is at right angle and the results of this type of drainage through the spermatic vein with confluence in the right angle in the renal vein are known. If in order to facilitate the manipulations the anastomosis is more proximal and more superficially carried out, then the renal vein will have its outlet counter-current into the external iliac thus constituting one of the most important causes of venous thrombosis. There are in addition other inconveniences:

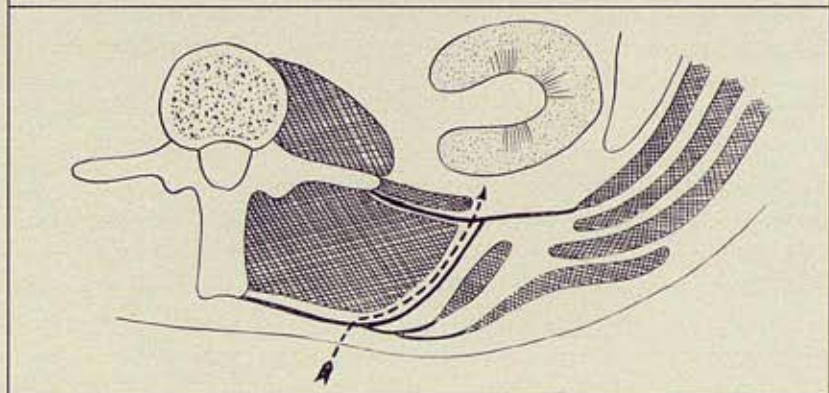
- The existence of valves in the external iliac and exactly at the anastomotic level producing a venous stagnancy favoring thrombosis. The resection of one of these valves created in one of our cases the formation of a thrombus about two centimeters long, with its basis in the bloody bed of the resected valve.

- The anastomosis may considerably reduce the iliac vein caliber thus creating a conflict in the return circulation.

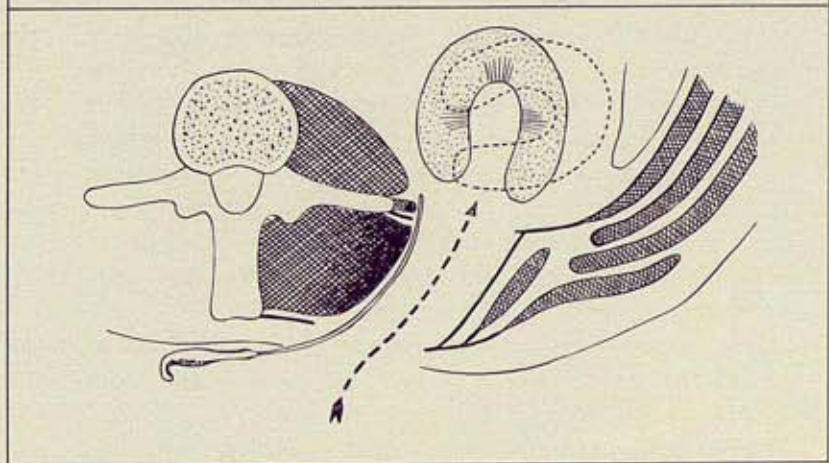
- The necessity for interrupting the venous circulation of the lower extremity although for 12 to 15 min. only, time required for the suture of the veins, constitutes a danger of immediate thrombotic complications, more frequent in these patients who on account



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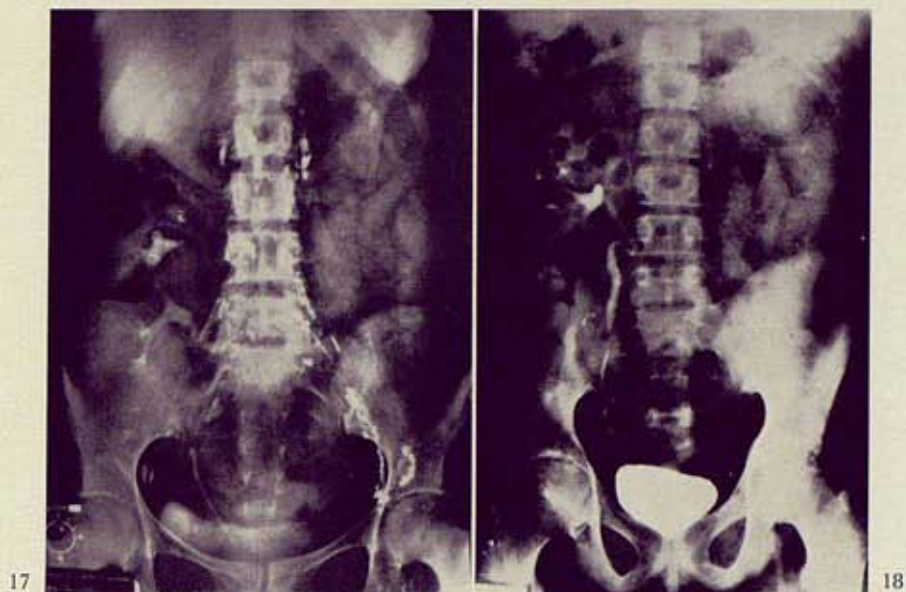


Fig. 17. U.I.V. of a renal transplantation with intrasinusal pyelo-pyelic anastomosis.

Fig. 18. U.I.V. of an adult cadaveric kidney transplanted to a girl through the same way of access and by the technique described. Kidney in lumboiliac position.

of their prolonged inactivity, dehydration, high degree of consumption and extreme weakness, are more susceptible to thrombophlebitis and phlebothrombosis, above all in this type of surgery.

— The end-to-end anastomosis with the internal iliac vein offers greater suturing difficulties because of the depth of the working field; it curls up and requires placing the kidney in the iliac fossa or in the pelvian excavation with the serious risk of kinking.

In order to avoid these complications, to facilitate the anastomotic manipulations, and to obtain a normal return circulation *we have used a new technique in our operations for the reestablishment of the venous circulation* (fig. 8).

Fig. 14. Posterior vertical lumbotomy incision for contralateral nephrectomy.

Fig. 15. Schematic section of our posterior lumbar way of access. Incision exclusively of big dorsal muscle and transverse muscle of the aponeurotic layers.

Fig. 16. Sacrolumbar mass and quadratus lumborum muscle retracted.

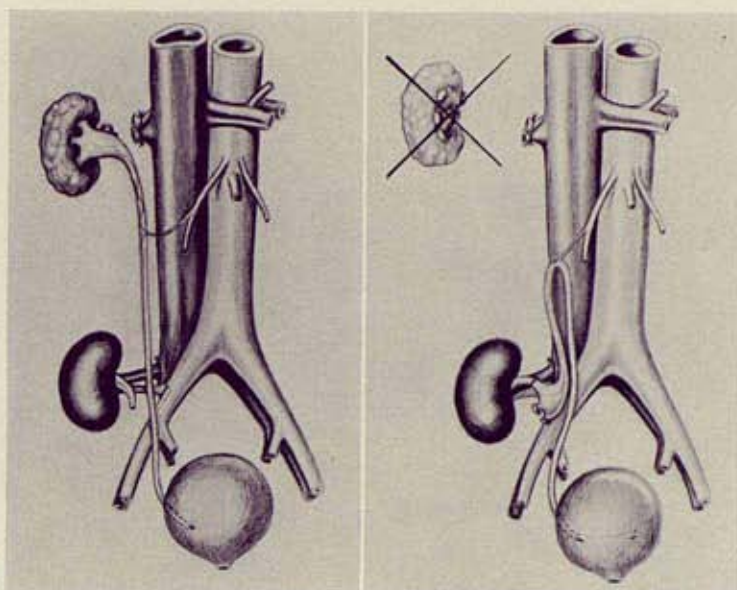


Fig. 19. Schematic drawing of a case in which a cadaveric kidney of a child was transplanted to an adult.

Fig. 20. Preceding case after the ureter anastomosis with one of the receiver's calices.

We prefer the right kidney for the graft, whether from a living donor or from a cadaver, by sectioning the renal vein with all its implantation basis and a small cuff of cava, having previously placed a Satinsky clamp laterally on the cava of the living donor, followed by continuous suture with Terylene 5/0. In the receiver, the cava is prepared at the level of the iliac veins confluence, interrupting the circulation at the iliac level by placing a Satinsky clamp laterally. Suturing of the renal cava cuff with the receiver's cava is done with Terylene 6/0 and continuous suture, placing three U-shaped stitches previously so as to avoid taking up the opposite wall.

The advantages of this reno-cava anastomosis over the classical reno-iliac are considerable:

1. Execution of the anastomotic suture is easier and much more comfortable to perform owing to the thickness of the cava vein, but above all because both anastomosis, to the cava as well as to the common iliac are carried out on a more superficial plane.

2. The normal vein outlet is exactly reproduced only lower down in an oblique direction, upwards and inwardly, i.e., in the direction of the venous flow.

3. Ample anastomotic stoma with no stricture possibilities.

4. Circulation in the lower member is never interrupted.

5. However short the renal vessels will be, with this iliac position of the graft, it is always possible to anastomose the renal to the cava; the artery must then be anastomosed end-to-side to the common iliac.

By this technique *venous anastomosis must always precede the arterial and not in the opposite way* as is customary, because after proceeding to the reno-cava anastomosis and placing the graft in a correct lumbo iliac position, it will then be decided which is preferable: anastomosis of the renal artery with the internal iliac, with the external, or with the primitive. The position spontaneously adopted by the graft and the length of its artery will determine the type of arterial anastomosis to adopt, never the reverse.

For the reestablishment of the arterial continuity we have followed the classical technique, end-to-end elliptical anastomosis, with the internal iliac (fig. 10), or the side-to-end with the external or common iliac (fig. 9) prior to a dissection of its wall in pastille and utilizing Terylene 6/0 instead of ordinary silk for the continuous suture.

When this last type of anastomosis is performed a gaseous embolism of the graft may occur if proper precautions are not taken, as we have had the opportunity to observe in one case. Having completed the anastomosis there will be an ample chamber of air left in the interior of the intersection formed by the anastomosed iliac and renal arteries which will have to be extracted by aspiration before removing the clamps. This is done by inserting a fine hypodermic needle connected to a syringe and the air is withdrawn until the arterial cavities collapse (fig. 9).

Although we give preference to the end-to-end anastomosis with the internal iliac the end-to-side and bevelled anastomosis with the common iliac or with the external has given us excellent results.

Friction and turbulency phenomena which theoretically may accompany this latter type of anastomosis have not indicated reduction of the renal blood flow. When a cadaver's kidney is used the occurrence of vaso-spasm of the renal trunk and of its main branches is relatively frequent, and is scarcely influenced by novo-

caine which may persist for some minutes, but which yielded in all the cases. The action of vasoconstrictors play an important rôle in the creation of this vaso-spasm when used in a massive form to maintain arterial tensions in preagonic stages as well as the normo-thermic time and cold perfusion.

In a graft proceeding from a living donor this vaso-spasm is caused by a different mechanism. The tractions practised over the kidney during the manipulations for its liberation as well as the dissection of its pedicle are causes which may release vasomotor reflexes, not only troncular but may even extend to the intrarenal arteries provoking ischemia of such dimensions that it might create acute tubular necrosis in spite of the short time of ischemia. This phenomenon observed by MORELLE may be avoided by a previous infiltration of the pedicle with novocaine and by using an atraumatic technique when extracting the graft. The rapid cooling of the graft at 4°C which is obtained by flushing and immersing the organ in a cold solution also produces a marked, although transitory increase of the renal vascular resistance at the moment when the blood circulation is reestablished, and which may be added to the vaso-spasm provoked by the anterior mechanism.

When more than one artery is present, the one of major caliber is to be anastomosed in end-to-side with the common or external iliac, and the one of minor caliber with one of the internal iliac branches end-to-end.

Other important aspects of technical surgery in renal homotransplantation are: incisions, selection of the kidney, situation of the kidney and its position.

Incisions. Experience has taught us that unless specific reasons to the contrary exist, such as uncontrollable hypertension or a serious infection of the kidney requiring previous bilateral nephrectomy, or the poor condition of the receiver, it is preferable to put off for a second stage the contralateral nephrectomy.

In view of the characteristics of the surgical technique we employ, the approach which offers a most appropriate operating field, the pararectal-extraperitoneal incision extending from above the costal border of the tenth rib until two finger widths within and above the inguinal orifice by which only aponeurotic layers are crossed (fig. 2).

A perfect dominion of the whole urinary excretory tract, of the bifurcation of the big vessels and of the iliacs is obtained through

this extraperitoneal way of access, thus facilitating the anastomosis of the renal vein to the cava, and the artery with the common iliac or with the internal iliac allowing moreover the extirpation of the receiver's homolateral kidney.

There is no need to section the spermatic cord nor the epigastric vessels with this type of incision, as it is done with the technique in use.

If nephrectomy of the contralateral kidney is necessary we prefer to perform it some months later in order to avoid extra operative trauma and to carry it out through a posterior vertical lumbotomy incision which, of all the approaches to the kidney, is the least traumatic (fig. 14) and offers more than sufficient operative field, especially for nephrectomies of small kidneys.

In a preceding bilateral nephrectomy as well as a contralateral nephrectomy we take special care to respect the whole of the excretory tract, pelvis included, which will be left *in situ* in case a second transplantation is required. If a preceding bilateral nephrectomy is required this should always be performed through the posterior vertical lumbotomy which is, we insist, less traumatic than the classical oblique lumbotomy and with no sequels.

Selection of the kidney. The majority of kidneys selected for transplantation have been on the left side until now. The authors give their preference to the right one owing to its longer vein which has to be anastomosed to the external iliac vein.

Although in our first cases we followed the usual technique described by KUSS, made popular by HUME and MURRAY and accepted by other surgeons, which undoubtedly has given good results, *we prefer to transplant the right kidney* especially if it is taken from a cadaver as it allows sectioning its vein together with a cava cuff thus improving and facilitating the anastomosis.

Moreover the right renal vein is more rapidly prepared having no affluents, as opposed to the left renal vein which is fed from the suprarenal, the spermatic, the ovarian, the ureterine, and sometimes the azygoslumbar trunk. The time required for its identification and ligation increases the ischemia time. In conclusion: it is easier to prepare the right renal vein than the left one because it involves less time and offers a larger anastomotic stoma. The shortness of the right renal vein is no obstacle when it is anastomosed to the cava. The right renal artery is longer and this facilitates anastomotic manipulations.

Situation of the graft. Although it has been accepted that the right kidney be implanted in the left iliac fossa, and the left kidney in the right iliac fossa, on principle, *whichever the kidney selected, right or left, we always place it in the right lumbo-iliac position.* Both must be inverted so that the upper pole be in the lower position and vice versa. By so doing the renal vein will be in the upper position directed towards the cava and the artery in the lower position directed to receive the internal iliac or to be anastomosed to the common or the external. When a renal pole – usually the upper – has an accessory artery (polar artery) this inverted position will facilitate the anastomosis of the said artery. The pelvis will be in anterior position in the right kidney, and posterior in the left.

In the event of having to perform a second transplantation it is preferable to utilize the left kidney with its total vein and to transplant it to the left iliac fossa, although such a position might be dangerous for the transplanted kidney. In such a case it is advisable to follow the second technique by Kuss by which the organ is situated in the left lumbar fossa anastomosing the vein with the renal and the artery with the splenic prior to nephrectomy and splenectomy of the receiver through transabdominal approach. Our method of utilization of the whole of the receiver's excretory tract may be used as complement to the said technique.

Position of the transplant. The position spontaneously adopted by the graft is of great importance, in that a bad position may create bending and kinking of the vein. The best position is the lumbo-iliac which is spontaneously adopted by the kidney when according to our technique it is anastomosed to the cava and needs no fixing. When a graft adopts an undesirable position and must undergo pexis, owing to the frailty of its capsule the kidney will soon reassume its original unsuitable position with all the consequences in the venous circulation. When a kidney is placed in the iliac fossa or in the pelvian excavation it will be in unstable equilibrium above the iliac psoas with a tendency to rotation and ascension by impulsion of the pelvian organs with the consequent risk for the renal vein. This will not occur with the anastomosis with the cava, when the kidney lies in a perfectly stable lumbo-iliac position. Another advantage of this higher situation of the kidney is that it provides a better contrast in the urographic pictures by not completely superposing the iliac bone as it happens with the graft in the pelvian position.

The homotransplantation of an adult kidney to a child will set up various problems if we follow the classical surgical technique. With regard to the size of the child's pelvis this is too small to house an adult kidney; there is disparity of caliber between the homograft's vessels and the iliacs of the receiver; and finally the distance between the kidney and the bladder will increase considerably with the child's growth rendering the ureter short. All this forces one to change the operative technique and tactics, while the transabdominal approach by itself, further complicates the operation. All these technical problems are completely solved if we follow the surgical technique herein described, and without the necessity of a transabdominal operation (fig. 18).

Surgical Results

In a total of 20 cases of grafts coming from cadaver and living donors, in which the pyelo-pyelic anastomosis without catheters was used, no complications like fistulas, stricture or ureteral reflux was observed; no extravasation, anastomosis dehiscence, urinary infections early or late.

The uro-cineradiographic exploration of the operated cases in the immediate as well as in the late operative stage has permitted the confirmation in each and every one of the absolute morphological and ureteropyelocalicial functional normality without the slightest physiological perturbation resulting from bending or kinks arising from pyelo-ureteral descent.

No case of thrombosis of the renal vein, nor stricture of the arterial anastomosis was observed.