Surgical Technic in En Bloc Bilateral Cadaveric Nephrectomy for Transplantation

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For the surgeon involved in securing cadaveric kidneys, the question often arises whether each kidney should be removed separately or both should be resected en bloc with the great vessels.

Although there are occasions when it is appropriate and even advantageous to resect the kidneys individually, the en bloc procedure is useful in certain situations. When multiple renal arteries are present, preserving the great vessels (especially the aorta) allows perfusion of both kidneys and all the renal arteries through one end of the aortic segment after the other end is tied off or clamped. This en bloc excision avoids trauma to the vessels, especially if the vessels are of small caliber. En bloc resection also makes it possible to transplant two pediatric-size kidneys into an adult when one kidney would be insufficient. Also, in en bloc resection, Carrel patches can be used for the implantation of multiple vessels at the appropriate site in the recipient.

In the en bloc resection, there are special sites of anatomic interest. (Figure 1.) These include the adrenal vessels, polar renal arteries, gonadal artery and vein, ureteral vasculature, and lumbar veins.

Technic

A wide bilateral subcostal incision (Chevron-type) is made for easy access to both renal fossae by the lateral approach. Hemostasis should be achieved to the extent possible in surgery of this urgency.

The descending colon is reflected medially, along with the mesentery of the small bowel, and is retracted with a wide Deaver retractor and large towels or a laparotomy pad previously moistened with saline. The descending colon is then placed cephalad and lateral to expose the left renal fossa and to allow retraction of the spleen, which is protected by another wet laparotomy pad. An incision is made longitudinally to separate the colon from the retroperitoneum, and the renal fossa is exposed after the lienocolic ligament has been sectioned. The descending and transverse colon, which has been retracted, is repositioned. Once the left kidney has been exposed, the lateral and posterior attachments of connective tissue are freed from the kidney by manual or blunt dissection. The Gerota fascia is then detached from the kidney surface; often, this detaching leads to minor but controllable bleeding. The left ureter is followed downward, with special care being taken to preserve the small renal pelvis branches that supply the upper third of the ureter. These branches will be the only vascular supply of the ureter after transplantation. To avoid detachment of the periureteral branches, dissection should be carried out approximately 1 cm from the ureteral wall medially and laterally and to a level below the iliac vessels. The ureter is transected with scissors. The gonadal vessels that are parallel to the ureter should be given particular attention. Rupture of these vessels may cause a hematoma, rendering dissection difficult. Next, the anterior aspect of the left hilus is approached; the renal vein is identified; and the branches are ligated separately with 4-0 silk sutures. The left gonadal vein enters the inferior border of the left renal vein approximately 1 cm from the hilus. The adrenal vein exits cephalad from the gland. The second lumbar venous branch that is posterior and joins the renal vein should be handled carefully. This branch can be easily torn, and if this occurs, the ensuing bleeding is profuse and difficult to control. The rest of the renal vein can be followed medially until it crosses the anterior surface of the aorta. Gentle retraction of the vein downward allows visualization of the left arterial supply, which is often multiple. With blunt gentle dissection, the renal arterial branches can be isolated and separated from the loose connective, lymphatic, and nervous tissues

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that surround them. The artery is followed medially to its point of takeoff from the lateroanterior border of the aorta. Turning the kidney anteriorly allows visualization of the posterior aspect to ensure that no further vascular connection is present at this level.

Exposure of the right kidney involves the same procedures except that the liver must be considered. The right lobe of the liver often is located in front of the right renal fossa. The right hemicolon is retracted medially and the liver is retracted cephalad by the same method as was used for the left side. Once the lateral gutter of the colon has been incised, the loose retroperitoneal tissue can be seen and the Gerota fascia, along with the surrounding fat, can be freed by blunt dissection. The posterior aspect of the kidney is then dissected free and exposed, and the ureter is isolated as was done on the left side. The anterior surface of the short right renal vein is freed up by blunt dissection (the right vein is more likely to have multiple branches than is the left vein). The right border of the inferior vena cava can now be easily seen. Gentle retraction of the vein prevents occlusion and permits visualization of the right renal artery, which arises from behind the inferior vena cava. Isolation of the artery is achieved by blunt gentle dissection. The posterior aspect of the kidney should be approached in such a manner as to ensure (as on the left side) that every nonvascular attachment around the kidney has been divided and that the renal artery is easily identifiable. The artery (or arteries) at this level should not be skeletonized because small branches that supply the kidney pelvis can become detached, and this produces bothersome hemorrhage.

After dissection of both kidneys has been completed and the ureters have been transected, the great vessels are approached. The small bowel is retracted to the right side and can be placed in a previously moistened plastic bag to facilitate handling. The transverse colon is retracted cephalad by use of a wide Deaver retractor. With this exposure, a vertical incision is made parallel to the left side of the ascending portion of the duodenum and medial to the inferior mesenteric vein and is extended downward to the aortic bifurcation. Cephalad, the incision should be prolonged above the level of origin of the superior mesenteric artery. The inferior vena cava is seen to the right of the aorta. Careful blunt dissection of the posterior aspect of these vessels is carried out bilaterally, and the lumbar branches that join it posteriorly are identified. These branches can be seen better by retracting the edges of the inferior vena cava by use of a wide vein retractor. The branches are secured, ligated with fine silk suture, and divided.

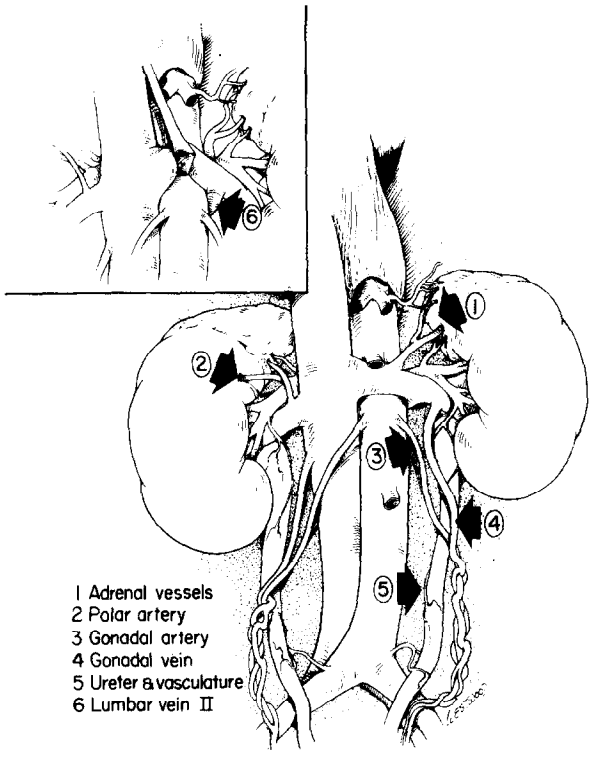

Figure 1. Important anatomic relationships and structures in en bloc bilateral nephrectomy.

Wide vascular tapes are placed around the inferior vena cava above and below the takeoff of the renal veins to allow for easy placement of vascular clamps about 1.5 cm above and below them, respectively.

The posterior aspect of the aorta is exposed by gentle retraction of the overlying left renal vein downward or upward, allowing ligation of the arterial lumbar branches. Knowledge of the number of renal arteries is essential to allow a safe approach to their region of takeoff, with several centimeters free above and below. Usually, no problem exists in dissecting downward except for the presence of more lumbar branches and possibly the inferior mesenteric artery to the left. In the cephalad direction, however, exposure is more difficult as the superior mesenteric artery is encountered. After ligation and division of this vessel, it is usually difficult to isolate the aorta and place the vascular tapes. Sectioning of both insertions of the medial arcuate ligament of the diaphragm has been helpful in performing this maneuver. (Figure 2.) The surgeon's index finger should be able to pass freely under the entire posterior surface of the aorta from the level of the superior mesenteric artery down to the inferior mesenteric artery and the proximal posterior aspect of the renal arteries.

With the dissection complete, vascular clamps (preferably small DeBakey clamps) may be placed

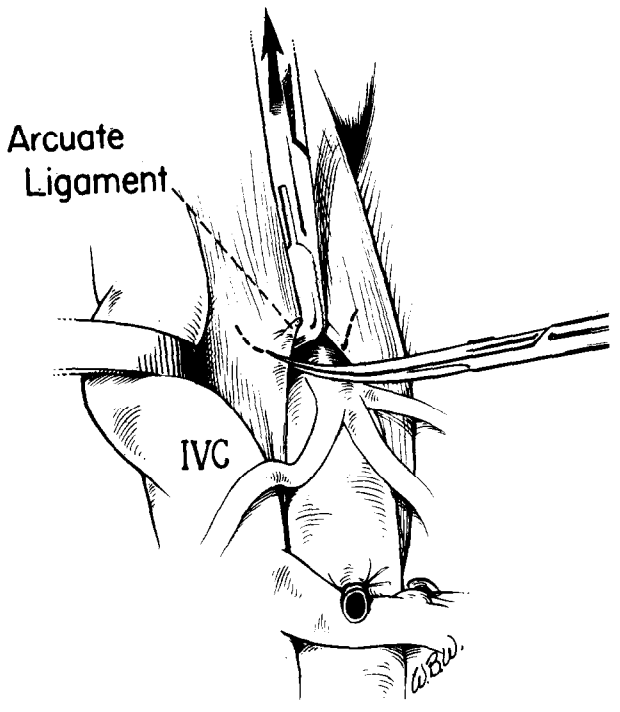

Figure 2. Cutting of arcuate ligament, allowing proximal exposure of aorta.

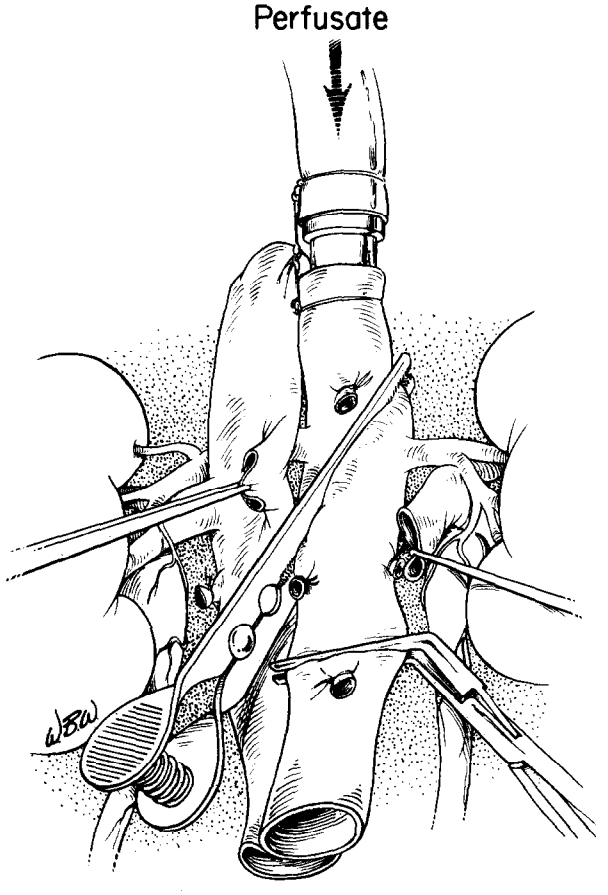

Figure 4. Clamping of aorta to permit removal of one kidney.

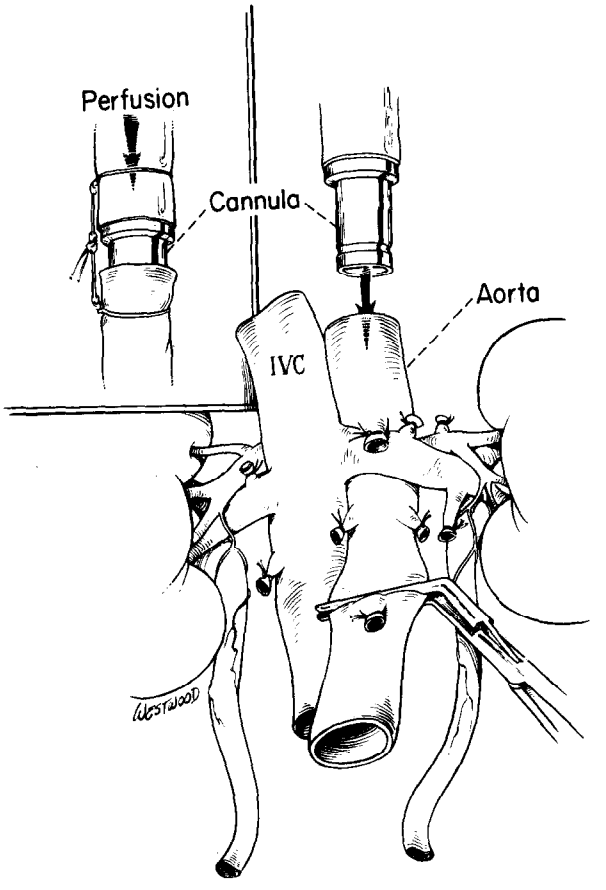

Figure 3. Cannulation and perfusion (inset) of aorta.

proximally and distally to the previously placed tapes without difficulty, first on the aorta and then on the inferior vena cava. Transection of the proximal and distal aorta is carried out, after which the distal and proximal inferior vena cava is transected. The surgeon's hand is introduced gently into the retroperitoneal space, which allows both kidneys to be pulled through together en bloc and ready for perfusion. In performing this maneuver, the surgeon should use extra care to avoid any rotation of the vascular pedicles.

Placement of a vascular clamp on the distal aorta or suture ligation below the takeoff of the renal arteries should allow for adequate perfusion after the introduction and fixation of a cannula of appropriate caliber to the proximal end. (Figure 3.) A clamp can be placed obliquely across the aorta to allow inflow from a perfusion pump to the arterial takeoff on one side, when one kidney is to be removed while the other remains on perfusion. (Figure 4.)

Comments

Freed et al [5] have discussed in detail the subject of bilateral nephrectomy for transplantation. Accu-

rate knowledge of the anatomy in the subdiaphragmatic region, especially with regard to the vasculature, is essential for any surgeon involved in kidney-harvesting procedures.

Studies concerned with variations in the renal vascular supply have been numerous. The frequent presence of multiple renal arteries due to the persistence of mesonephric vessels is well known. However, the data regarding their disposition and number vary somewhat. In a review of almost 11,000 kidneys, Merklin and Michels [*1*] noted that 72 per cent had a single artery. This is in agreement with the incidence of 32 per cent of multiple arteries mentioned by Pick and Anson [*4*]. In a study of 500 cadavers, Reis and Esenther [*3*] found 85.4 per cent of single arteries on the right side compared with 80.6 per cent on the left.

The existence of polar arteries is also well documented. The study by Merklin and Michels [*1*] indicated that approximately 12.5 per cent of the kidneys had two arteries of aortic origin: one entering the hilus and the other being either an upper or lower polar artery. Another report indicated that 13.4 per cent have polar arteries, the upper one being commonly derived from a source other than the aorta. It should be emphasized that a polar branch represents a segmental supply of the kidney parenchyma and has a different embryologic origin.

Smith et al [2] have noted that the venous variations are less common and are less important in the dissection because of the nonsegmental nature of the venous drainage of the kidney. Reis and Esenther [*3*] found that multiple veins are more common on the right side compared with the left side (10.8 per cent versus near 0 per cent). Other variations of the left venous drainage occur in a few patients. The left renal vein is posterior to the aorta in about 3 per cent of the patients, as reported by Pick and Anson [*4*], and the persistence of the "renal collar" is always mentioned by the anatomists; both anomalies result from persistent venous communications between the cardinal systems of the two sides in the embryo. Pick and Anson [*4*] and Reis and Esenther [*3*] noted that the frequency of venous rings around the aorta varies from 6 to 16.8 per cent.

Attention is given in our dissection to the ligation of the second venous lumbar branch that connects with the left renal vein. The ascending lumbar vein giving origin to the hemiazygos vein is posterior to the left renal pedicle and communicates with it.

The anteroposterior relationship of the renal pedicle at the level of the hilus is not always present. Among 125 specimens studied by Anson and Daseler [*6*], the renal artery was dorsal to the renal vein in only 58 on the right side and 61 on the left side.

Sectioning of the medial arcuate ligament of the diaphragm on both sides of the vertebral column offers sufficient exposure of the celiac axis and allows easy placement of the clamps after ligation and sectioning of the superior mesenteric artery.

Removing both kidneys en bloc with the attached big vessels allows perfusion of both kidneys through the aorta and avoids the trauma of cannulation of the renal arteries. Retaining the entire aorta and inferior vena cava allows for the best possible anastomotic design in the recipient. When both kidneys are small (as in an infant), they can be conveniently implanted in an adult recipient or aortic patches may be used to anastomose the small vessels.

Additionally, we believe this procedure should be performed in "heart beating" cadavers. Maneuvers for external massage, with the abnormal excursion of the diaphragm produced by them, interfere significantly with accurate surgical technic in donors with cardiac arrest. The chief goal is implantation of a kidney that has the least possible warm ischemia time, followed by immediate and optimal preservation.

Summary

En bloc bilateral cadaveric nephrectomy for transplantation has some advantages over excision of each kidney separately. There is also an advantage of single cannula perfusion through the aorta for two kidneys, especially when multiple renal arteries are present. The anatomic vascular variants are important, as are the incision and the approach to the suprarenal aorta and the lumbar venous drainage of the kidney.

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