1. Introduction

Laparoscopic living donor nephrectomy has become the standard procedure for renal transplantation. This technique is considered the less invasive procedure for the donor, allowing lower postoperative analgesic requirements and a faster return to daily activities [1,2]. Concerns about adequate
length of the right renal vein have resulted in more laparoscopic donor nephrectomies being done on the left side [3], conflicting with the principle of leaving the donor with the best kidney. Although right nephrectomies are not more technically challenging than left nephrectomies, the short length of the right renal vein restrains the routine use of the right kidney for transplantation purposes.

While standard techniques for laparoscopic control of the renal pedicle have been well described in the literature [4], preservation of the maximum length of the right renal vein continues to be a challenge for the surgeons.

The use of stapler devices for control of the renal vessels during laparoscopic nephrectomy has become standard practice. We report our current method to maximize the length of the right renal vein using a modified Endo GIA 30 Universal stapler (30-mm length, 2.5-mm staples; Tyco Autosuture, U.S. Surgical, Norwalk, CT, USA).

In the search done in the international literature, we could not find an analog of the tool that we describe to achieve maximal length of the renal vein during laparoscopic live donor kidney harvesting.

2. Material and methods

From January to August 2006, nine live donors were evaluated with standard medical, surgical, and psychosocial preransplant examinations, including vascular imaging with renal angio computed tomography (CT) scan with 3D reconstruction (Table 1).

The indications to perform right donor nephrectomy were better kidney function on the left side and favorable anatomy of the right kidney pedicle.

All the procedures were performed by the same surgeon (R.B.), who used the transperitoneal approach.

We describe our technique for the right nephrectomy. The trocars and laparoscopic instruments used for the right side nephrectomy were 1 × 10 mm (for the optic 0°), 1 × 12 mm (for the Endo GIA and bipolar grasper) and 3 × 5 mm (for the monopolar scissors, suction device, and liver retractor grasper).

The patient was positioned in a modified lateral decubitus position and the table flexed for right flank hyperextension. Five ports were used for right-sided nephrectomy. The pneumoperitoneum was established via a Veress needle placed two finger widths below the right costal margin arch, at the level of the lateral border of the rectus muscle. The Veress needle was replaced by a 10-mm port, and a 0-degree optic lens was introduced through the port. The triangulation rule was used for the placement, under direct vision, of the second and third trocars, as the body habitus changed among patients. The fourth port was inserted midline between the umbilical trocar and the anterior iliac crest on the side of the procedure. The fifth port (5 mm) was placed two finger widths below the level of the second port for the introduction of the liver retractor. The ascending colon was mobilized and dissected from the underlying Gerota’s fascia, extending caudally to the common iliac vessels. Following the medial mobilization of the colon and mesocolon, the gonadal vessels were visualized underneath the Gerota’s fascia. The Gerota’s fatty tissue at the level of the lower pole of the kidney was incised and lifted to locate the psoas muscle. The psoas was followed to expose the ureter just lateral to and deep to the gonadal vessels. By tracking the cephalic course of the ureter, the plane was followed up to the renal pedicle. Caudally, the ureter was dissected and liberated until the crossing of the iliac vessels. The ureter was not divided at this time. The duodenum was mobilized medially by performing a Kocher maneuver until the vena cava was clearly visualized. The vena cava was laterally mobilized, and the left renal vein was dissected and gently displaced, to expose the plane between the aorta and the inferior vena cava. At this level, the right renal artery was dissected and exposed at its origin. (Fig. 1). The right renal vein was dissected at the lateral border of the vena cava. The adrenal gland was separated from the upper pole of the kidney, and the division of the attachments of the liver to the upper pole of the kidney was facilitated by the liver retractor. The posterior and lateral attachments of the kidney to the abdominal wall were released by blunt and sharp dissection. Inferiorly, the ureter was ligated with one

<table>
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<th>Table 1 – Patient characteristics</th>
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<tr>
<td><strong>No. of patients</strong></td>
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<td><strong>Male (no. [%])</strong></td>
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<td><strong>Female (no. [%])</strong></td>
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<tr>
<td><strong>Mean age (yr)</strong></td>
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<td><strong>Mean body mass index</strong></td>
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<td><strong>Mean donor preoperative serum creatinine (mg/dl)</strong></td>
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<td><strong>Mean donor glomerular filtration rate (ml/min/1.73 m²)</strong></td>
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SD = standard deviation.

Fig. 1 – (A) Vena cava, (B) left renal vein, (C) right renal artery, and (D) intercavoaortic space.
large extra-large Hem-o-Lok polymer clip (Weck; Teleflex Medical, Research Triangle Park, NC, USA) applied to its most distal portion; it was then transected to allow the kidney to be fully mobilized. A 6–8 cm lower ilioinguinal incision was performed, but the muscle attached to the peritoneum was not incised to preserve the pneumoperitoneum. A large laparotomy bag (Endocatch II 15 mm, Tyco Autosuture) was introduced through a small opening of the peritoneum at the ilio-inguinal incision. The kidney, attached only to the hilum, was placed into the bag and the Endocatch arm was pulled out to partially close the metal ring around the hilum (Fig. 2).

At this time, two extra-large Hem-O-Lok polymer clips were applied to the proximal portion of the renal artery at the interaortocaval space, without cutting it. The multifire Endo GIA 30 stapler (Tyco Autosuture) was used for securing and transecting the main right renal vein, but in our technique the triple staggered rows of staples of the kidney side were removed to allow for a longer donor vein. By cutting the fixation of the pusher (Fig. 3) at its base with a scalpel and then firing it, the staples were completely released (Fig. 4). The empty rows were yellow in color, facilitating the visualization of the correct side of the Endo GIA stapler that would be applied to the renal vein, therefore avoiding misplacement of the empty side of the unit (Fig. 5).

The right renal vein was gently stretched, stapled, and divided at the lateral border of the vena cava, with the use of the Multifire Endo GIA stapler (Tyco Autosuture) introduced through the third port (12 mm). The tension on the renal vein placed the row of staples on the lateral part of the vena cava (Fig. 6), and increased the length of the donor vein.

Once all the hilar vessels had been divided, a simple digital avulsion of the muscle and peritoneum around the arm of the Endocatch opened completely the ilioinguinal incision, allowing the Endocatch II (Tyco Autosuture), with the specimen inside, to be easily removed. The kidney was then taken to the bench, where it was flushed with the preservation solution (HTK Custodiol; Tramedico).

The abdominal wall was closed with running Vycril 2-0 suture for the peritoneum, interrupted Vycril 0 suture for the muscle, and running Vycril 1 suture for the aponeurosis. The pneumoperitoneum was reestablished, and the optic was reintroduced for revision of the hemostasis. A silicone Penrose
in all patients and no graft was lost. The mean receptor postoperative creatinine and glomerular filtration rate at 30 d were 1.26 ml/dl and 67.3 ml/min, respectively. One patient presented a postoperative lymphorrhage for which treatment was conservative. The mean follow-up was 4.1 mo.

4. Discussion

Renal transplantation has a major impact on the survival and quality of life of those suffering from kidney failure. As evidence has accumulated indicating that live donor nephrectomy entails a “low surgical risk” [5], and because of the shortage of cadaver organs [6], the transplant community continues to accept live donation. Laparoscopically harvested live donor renal grafts were introduced in 1995; this technique has been proposed as a less invasive and more convenient procedure for the donor [7]. The left kidney has been systematically preferred for live donor nephrectomy because of the longer left renal vein and the need for liver retraction during right nephrectomy [8]. However, there are instances that preclude the harvesting of the left kidney, like multiple renal arteries or veins, a cystic mass or a smaller right kidney, and a 10% decrease in the renal function compared with the left kidney [9].

The problem with right kidneys is not with the donor but with the recipient because of the short vein. In fact, right kidneys are located lower, the artery is longer, and the vein has no tributaries as does the left renal vein. Nevertheless, the procurement of the right kidney is still viewed with reluctance [9,10]. Concerns about adequate length of the right renal vein have resulted in more than 98% of laparoscopic donor nephrectomies being done on the left side [3]. In the large series from the University of Maryland, only 29 right kidneys (4%) were obtained laparoscopically [11]. More importantly, concern has been raised regarding a higher incidence of venous thrombosis related to right-sided donor nephrectomies, postulated to be from the short renal vein [8]. Alternatively, Erasmus Medical Center Rotterdam advocates right side live donor nephrectomy because operating time was significantly shorter in the right live donor nephrectomy group [12].

In the case of open surgery or hand-assisted living donor procedures, the vena cava can be clamped and the renal vein taken in its full length. For laparoscopic donor nephrectomy, this maximal length cannot be obtained, and the renal vein is usually 2 to 3 mm shorter compared with the open
surgery. This anatomic problem increases the technical difficulty of the implantation, promoting the search for new methods to obtain additional length of the renal vein.

The maximizing of the length of the renal vein during laparoscopic live donor nephrectomy using vascular Satinsky clamp has been published [13]. However, misplacement of the clamp or inadequate suture of the vena cava can lead to technically dangerous difficulties. In addition, the subcostal incision diminishes the benefits of the pure laparoscopic procedure. Others have described techniques for prolongation of the length of the renal vein using donor or recipient vascular graft, such as gonadal vein [14] or recipient greater saphenous vein [8]. Application of a loop constructed from a 0 silk tie has not achieved the goal of maximizing renal vein length [15].

The use of Hem-o-Lok polymer clips to control and increase the length of the vessels during live donor nephrectomy has been described [16]. Recently, Teleflex Medical has included live donor nephrectomy as a contraindication for the use of its Hem-o-Lok clips at the renal artery because the clips may dislodge [17]. Nevertheless, they can still be used without restriction in all other laparoscopic procedures. In our view, the failure of the Hem-o-Lok clips is not caused by limitations of the device, but by the specific requirements of the live donor graft. The explanation can be attributable to the fact that the surgeon tries to maximize the length of the renal artery, but does not respect the 2-mm sleeve of vessel beyond the clip.

The problem with the renal vein is distinct. The stretching of the vessel, while placing the Hem-o-Lok, increases the risk of positioning the clip on the vena cava instead of placing it on the renal vein. As a result, the device on the vena cava can dislodge because of the increased pressure on the vessel’s wall.

The use of stapler devices for control of the renal vessels during laparoscopic nephrectomy has become standard practice [4–12]. The Endo-TA 30 stapler (30-mm length, 2.5-mm staples; Autosuture) places a single row of staples on the vessel, but the surgeon needs to divide the vessels with scissors, compromising the vessel length [18]. The endovascular gastrointestinal anastomosis (Endo GIA) stapling cutting device places two triple-staggered rows of staples on the vessels and further divides them with an internal knife. The usual problem encountered when using the Endo GIA stapler device is the need to trim the staples from the graft vessels [13–19] before performing the anastomosis, therefore shortening the length of the vein for 5 mm. The length of the renal vein is also reduced for approximately 15 mm if the vessel is not stretched before applying the stapler device.

We solved this problem with a simple technical modification of the Endo GIA 30stapler, in which the triple staggered rows of staples from the kidney side are removed. The rows of staples were initially removed individually with the use of a thin needle. Recently we simplified the technique even further: By cutting the fixation of the pusher at its base with a scalpel and then firing it, the staples were completely released. Regarding the renal artery, although rarely a problem, this vessel can be potentially short because of limited exposure resulting from the overlying vena cava. Techniques for maximizing renal arterial length, utilizing laparoscopic interaortocaval and retrocaval dissection, have been described [20,21].

An extraperitoneal laparoscopic approach allows full access of the renal artery on the right side. Nevertheless, in case of major bleeding, the main vessels become immediately obscured by the blood overflow, increasing the risk of conversion compared with the transabdominal approach. In the latter, the hemiabdomen on the down (opposite) side accommodates the excess blood, giving the surgeon extra time to control the bleeding. Furthermore, the extraperitoneal approach limits the removal of the kidney in a more esthetic place, as the access to the lower abdomen is more restricted.

Regarding the extraction of the donor graft, we insert the kidney inside the Endocatch bag before ligating the pedicle and remove the specimen through a lower ilioinguinal incision. In our view, this incision is more comfortable and esthetic as

Fig. 7 – (A) Vena cava, (B) stapled right renal vein, (C) stapled right renal artery and vein, (D) Hem-o-Lok to right renal artery, and (E) right adrenal gland preserved.
opposed to extracting the graft via a flank incision [22] or midline incision [23], respectively.

In combining our modified Endo GIA vascular stapler technique with the described interaortocaval access [20], we first ligate the renal artery at the ostium with two Hem-o-Lok clips; then the pedicle en bloc is stapled and cut at the lateral border of the vena cava (Fig. 7). The stapling of the artery may shorten the vessel, but, on the other hand, a safer control of the artery is obtained and the risk of arteriovenous fistulas is eliminated.

5. Conclusions

We describe a novel laparoscopic technique for live donor right nephrectomy using a modified Endo GIA stapler to obtain the full length of the right renal vein. This technique allows for an easy vascular anastomosis without vein reconstruction, and it does not compromise warm ischemia time. It also enables full control of hemostasis after section of the renal vein.

Conflicts of interest

The authors have nothing to disclose.

References