Laparoscopic Vascular Control Techniques in Donor Nephrectomy: Effects on Vessel Length

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Laparoscopic Vascular Control Techniques in Donor Nephrectomy: Effects on Vessel Length

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ABSTRACT

Background: Various techniques for vascular control have been used during urologic laparoscopic procedures. The importance of optimizing the vessel length and securing reliable vascular control are critical for procedures like laparoscopic donor nephrectomy. We aimed to determine the length of vessel lost by using 4 common techniques of vascular control in a fresh human cadaveric vascular model.

Methods: The techniques include application of 2 nonabsorbable polymer-ligating clips (10-mm Hem-o-Lok MLX Weck Closure Systems, Research Triangle Park, NC), Endo-GIA II stapler (30-mm length, 2.5-mm staples, Auto Suture, US Surgical, Norwalk, CT), Endopath ETS35 stapler (35mm length, 2.5mm staples, Ethicon Endo-Surgery), and the Endo Ta-30 stapler (30-mm length, 2.5-mm staples, Auto Suture, US Surgical, Norwalk, CT).

Results: The Endo-TA-30 stapler and the polymer clips resulted in significantly less compromise of the vessel length, when compared with the other methods of vascular control.

Conclusions: The Endo-TA-30 stapler and the polymer clips can be applied during laparoscopic procedures where optimizing vascular length is important.

Key Words: Stapler, Vascular, Laparoscopy, Donor, Nephrectomy.

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INTRODUCTION

Stapling devices have been used for intestinal, pulmonary, and vascular applications.[1–5] Laparoscopic donor nephrectomy has been used since 1995 and has become the preferred procedure for live renal transplantation at many centers in the world. The benefits of laparoscopic surgery over open procedures include more rapid recovery, diminished analgesic requirements, improved cosmesis, and equivalent graft function.[6–11] One disadvantage of the laparoscopic approach, albeit rare, is failure of the laparoscopic staplers, which can result in significant bleeding. Additionally, vascular ligation may result in some loss of blood vessel length when compared with that in open techniques. This may become increasingly important with the increasing rates of donation and subsequent use of right-sided donors.[11,12] We aimed to investigate the amount of vessel length lost with various common techniques of vascular control in a human cadaveric vascular model.

METHODS

The inferior vena cava, iliac veins, renal veins, aorta, and iliac arteries were harvested from 3 fresh human cadavers through a midline incision. The vessels were then prepared, secured to a board with pins, and 4 common techniques of vascular division were used:

(1) 2 nonabsorbable polymer ligating clips (10-mm Hem-o-Lok MLX Weck Closure Systems, Research Triangle, NC);

(2) Endo-GIA II stapler (30-mm length, 2.5-mm staples, Auto Suture, US Surgical, Norwalk, CT);

(3) Endopath ETS35 stapler (35-mm length, 2.5-mm staples, Ethicon Endo-Surgery) and;

(4) Endo Ta-30 stapler (30-mm length, 2.5-mm staples, Auto Suture, US Surgical, Norwalk, CT).

We attempted to determine the length of blood vessel lost with each method of vascular division. The Endo-GIA stapler fires 6 rows of staggered staples, and cuts between rows 3 and 4. We trimmed the stapled end to measure the amount of vessel lost. The Endo Ta-30 stapler deploys 3 rows of staggered staples, but does not cut. With this stapler, we sharply divided the "graft" side of the vessel and left the 3 rows of staples with the "patient" side to measure the vessel length. Two 10-mm Hem-o-Lok clips were placed as close together as possible on the "patient" side of the vessel and the vessel then sharply transected by the second clip, leaving a 1-mm cuff of tissue. Each technique was applied, and the length recorded by the same investigator using calipers. Fifteen attempts were made using each method.

Statistical analyses were performed using ANOVA to compare the vessel-length data among the 4 kinds of staples, followed by a post-hoc pair-wise comparison between groups. A Box-Cox transformation was performed for the length data to comply with the normal distribution assumption. Length differences were based on squared lengths.

RESULTS

Using the Endo-TA-30, the length lost was 0.50±0.13 cm, which was significantly shorter ($P<0.001$) than that with the 2 Hem-o-Lok clips, where the average vessel length lost was 0.77±0.05cm. The use of 2 Hem-o-Lok clips was associated with significantly smaller vessel loss ($P<0.001$) when compared with loss with the Endo-GIA II (1.01±0.07 cm) **(Figures 1 and 2)**. Vascular division using the Endo-GIA resulted in significantly less ($P<0.003$) vessel loss when compared with loss with the Endopath ETS35 (1.08±0.05 cm) **(Table 1)**. No significant difference existed in the loss of vascular lengths between the arteries and veins.

Figure 1. Nonabsorbable polymer ligating clips (10-mm Hem-o-Lok MLX Weck Closure Systems), Endo Ta-30 stapler (30-mm length, 2.5-mm staples, Auto Suture), and Endo-GIA II stapler (35-mm length, 2.5-mm staples, Auto Suture). From top to bottom.

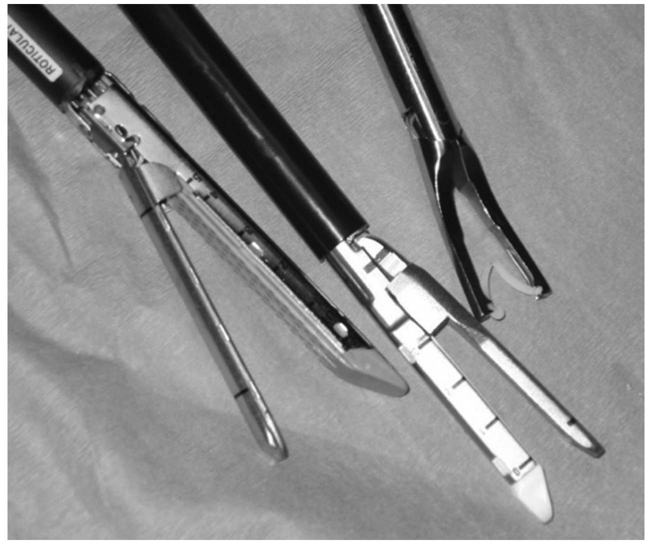

Figure 2. Stapler heads of Endo GIA II and Endo-TA-30 staplers, and 10-mm polymer ligating clips. From left to right.

DISCUSSION

Laparoscopic donor nephrectomy has duplicated the success of open surgery, while minimizing patient morbidity and analgesic requirement. With continued and increased use of laparoscopy for donor nephrectomy, safety for the donor and adequate graft quality are critical. One important requirement is obtaining adequate vessel length. This is especially true for right-sided donors where the vein tends to be shorter and in patients with multiple arteries.[13] Suture ligation is the standard method of vascular control during open donor nephrectomy. However, this cannot be expeditiously done via the laparoscopic approach. Practical issues with the vascular staplers are important to understand. Staplers, while generally reliable, can malfunction. Deng et al[14] reported 55 cases from the Food and Drug Administration database of endovascular gastrointestinal stapling device complications. Twenty-two events occurred during laparoscopic donor nephrectomy but did not result in graft dysfunction or loss. Chan et al[15] reported a series of 10 cases of endovascular stapler malfunction during 565 laparoscopic radical nephrectomies using the Endo-GIA. Although the failure rate was only 1.7%, this is a salient concern for those performing laparoscopic donor nephrectomy using staplers. The Endo TA stapler is potentially safer than the other 2 staplers that divide the vessels between 3 rows of staples on each side. The

Table 1.
Vascular Ligation and Blood Vessel Length Lost

Ligation Technique	#Trials	Mean Length (cm)	Standard Deviation	*P* Value
Endo-TA-30	15	0.50 (0.23 to 0.67)	0.13	<0.001
2 Hem-o-Lok clips	15	0.77 (0.69 to 0.85)	0.05	<0.001
Endo-GIA II	15	1.01 (0.92 to 1.14)	0.07	<0.003
Endopath ETS35	15	1.08 (0.96 to 1.15)	0.05	—

Endopath ETS35 stapler does not open easily when maximally articulated. The Endo-GIA, while reliable and articulating, requires 2 hands to operate. The Endo-TA does not articulate. This could result in some vessel length loss if the stapler is not placed flush with the vessel. This could be a significant drawback if an appropriately placed trocar is not used during a laparoscopic donor nephrectomy. The future development of the TA stapler with articulation could overcome this problem. We use the most medial trocar for the Endo TA to achieve the best possible angle with the origin of the renal artery. The smaller length of the clip compared with the Hemo-o-Lok TA stapler allows the clip to be accurately applied on the artery close to its origin from the aorta, even when the trocar is not ideally placed. If 2 polymer clips are used, the warm ischemia time could be increased due to the need to reload clips. Having a second clip applier could minimize this. We currently use Hem-o-Lok clips or the Endo-TA stapler for the vessels, depending on the vascular anatomy and relationship of the vessels to the trocars.

Meng et al[16] described their experience with laparoscopic donor nephrectomy in 97 patients. The initial 15 patients had both vessels transected with the Endo-GIA stapler. One of these patients required open conversion due to significant bleeding at the renal arterial staple line. In the remaining 82 patients, 1 polymer clip and 1 titanium clip were placed on the artery, while the Endo-TA stapler was used on the vein. Janetschek et al[17] described, in 20 patients undergoing radical nephrectomy, a technique that provides safety with vascular control while avoiding the use of stapling devices. In this series, after the renal artery is divided, a suture is passed around the renal vein, tied down extracorporeally to shrink the renal vein, a polymer clip placed, and the vessel divided. The assertion here was that this method provides for safe and secure vascular ligation, while obviating the cost **(Table 2)** of a stapler and potential for stapler failure. Recent studies have demonstrated the safety of polymer clips, and no reports exist of polymer clips dislodging postoperatively.[18,19] The clip may become dislodged if not applied correctly. We have observed this during surgery where the second clip is dislodged when the vessel is divided flush with the clip. It is therefore important to leave a sleeve of vessel distal to the second clip. When the clip is used, the artery must be circumferentially dissected to ensure that perivascular tissue does not impede secure locking of the clip. Though the initial cost of the reusable (Weck) clip applier is high, the cost of the applier and clips averaged over 50 cases is only $49 per patient. Considerable savings are realized if clips are used instead of staplers. The inadvertent entrapment of previously placed clips on adjacent vessels, within the jaws of the staplers can result in stapler malfunction. At our institution, we minimize stapler failure by using bipolar coagulation for control of the tributaries of the renal vein, which avoids placing clips near the renal hilum.

Table 2.
List Prices of Staplers and Reloads

Device	List Price
US Surgical Endo-GIA + cartridge	$499
US Surgical Endo-GIA reload	$258
US Surgical Endo TA-30+ cartridge	$375
US Surgical Endo TA-30 reload	$176
Ethicon ATW35 Stapler	$184
Ethicon TR35W Reload	$80
Weck 10-mm Clip applier	$1395
Weck 10-mm Hem-o-Lok Cartridge (6 clips)	$21
Weck 5-mm Clip applier	$1195
Weck 5-mm Hem-o-Lok Cartridge (6 clips)	$27

Although statistical significance was determined between all methods of vascular division, the clinical significance may be minimal in the vast majority of patients as the mean difference in length lost between the Endo-TA and the Endopath ETS35 is less than 1cm (0.50cm vs 1.08cm). A small addition of transplant renal vascular length may be significant in situations like right-sided donor nephrectomies, multiple arteries, and in some recipients due to the recipient vascular anatomy or body habitus.

CONCLUSION

Various techniques are used to divide the blood vessels during procedures, such as laparoscopic donor nephrectomy. In this cadaveric model, the Endo-TA-30 stapler and the placement of 2 polymer locking clips resulted in significantly less compromise of the vessel length, when compared with the other vascular staplers. These 2 techniques could be applied during laparoscopic procedures where optimizing vascular length is important. The appropriate technique for vascular control can be individualized to each patient during laparoscopic donor nephrectomy, depending on the vascular anatomy.

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