ELSEVIER

HEMOSTATIC LAPAROSCOPIC PARTIAL NEPHRECTOMY ASSISTED BY A WATER-COOLED, HIGH-DENSITY, MONOPOLAR DEVICE WITHOUT RENAL VASCULAR CONTROL

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ABSTRACT

Objectives. To evaluate the feasibility of laparoscopic partial nephrectomy assisted by a water-cooled, high-density, monopolar device (TissueLink Floating Ball).

Methods. Transperitoneal laparoscopic partial nephrectomy was performed without vascular control for four renal tumors in 3 patients. A flexible ultrasound probe was used to confirm tumor location and depth. Gerota's fascia was opened distant from the tumor site. Renal fat was dissected from the renal parenchyma except for the fat overlying the tumor. The tumor resection area was marked 1 cm outside the boundaries of the tumor. After application of the TissueLink Floating Ball at the planned surgical margin, the tumor was resected with cold laparoscopic scissors. Bleeding from the vessels of the divided renal parenchyma was controlled with the Floating Ball if necessary. The specimen was sent for frozen section to confirm margin status.

Results. Mean estimated blood loss per tumor was 275 mL. The dissection extended to the collecting system in 2 of 4 cases. In 1 patient, a minor postoperative urine leak resolved spontaneously.

Conclusions. Use of the TissueLink Floating Ball facilitated resection of small renal tumors without renal vascular control. Although further study is necessary, water-cooled, high-density monopolar energy may have a role in laparoscopic partial nephrectomy.

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Traditionally, partial nephrectomy has been performed by flank incision. This incision is associated with significant postoperative morbidity, high analgesic requirement, extended hospital stay, and prolonged convalescence. Laparoscopic partial nephrectomy may decrease pain and expedite convalescence, but has remained technically challenging, due primarily to the difficulties in hemostasis. Although various techniques have been introduced to reduce blood loss at partial nephrectomy,[1–4] they have not gained widespread acceptance. We applied the TissueLink Floating Ball to assist with hemostasis during surgery (Fig. 1). TissueLink Floating Ball technology incorporates a water-cooled, high-density, monopolar current. Tissue cooling with saline limits the increased tissue impedance associated with carbonization-facilitating hemostasis. This technology has been used successfully in several patients undergoing hepatic resection.

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MATERIAL AND METHODS

Case 1

A 72-year-old man with a history of prostate cancer, coronary artery disease, and hypertension had an incidental finding of an enhancing left renal mass of 2.6 × 2.4 cm (Fig. 2A). A laparoscopic transperitoneal partial nephrectomy was performed without clamping the renal vessels, with the assistance of the TissueLink Floating Ball (TissueLink Medical, Dover, NH). Intraoperative blood loss was 150 mL (Table I). The patient was discharged on postoperative day 2, following computed tomography (CT) imaging 1 day after surgery (Fig. 2B). Histopathologic study revealed a papillary renal cell carcinoma with a surgical margin of 3 to 5 mm.

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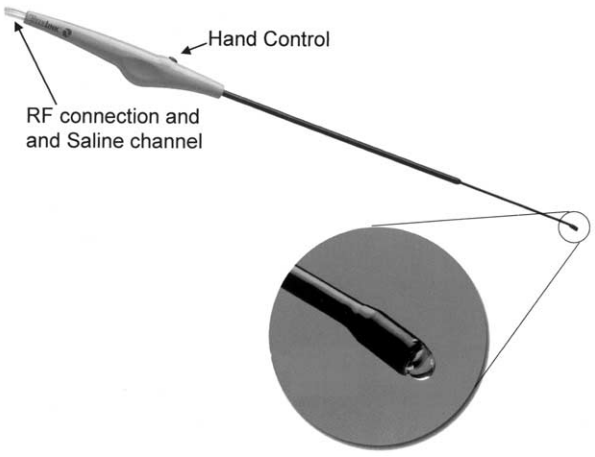


FIGURE 1. *The TissueLink Floating Ball system showing a close-up view of the tip of the device with a drop of saline.*

A

B

FIGURE 2. *(A) Preoperative CT scans with the renal tumor, and (B) on postoperative day 1, showing depth of resection in patient 1.*

Case 2

A 54-year-old man with recently diagnosed prostate cancer underwent a CT scan that revealed two enhancing masses in the right kidney: a 2 × 1.2-cm hilar lesion and a 1 × 1-cm tumor in the lower pole (Fig. 3A). The patient chose to undergo brachytherapy for prostate cancer. Using a retroperitoneal laparoscopic approach, Floating Ball partial nephrectomy procedures were performed. Estimated blood loss was 300 mL for the lower pole lesion and 150 mL for the hilar lesion. CT scan on postoperative day 1 confirmed renal surgical defects without perinephric collections (Fig. 3B). The perinephric drainage fluid was studied for creatinine level; a small urine leak was detected with an output of less than 50 mL/d. The drain was removed in the first week postoperatively after spontaneous resolution of the leak. The patient was discharged on postoperative day 2. Histopathologic study revealed both lesions to be angiomyolipomas with surgical margins of 3 to 5 mm.

Case 3

A 75-year-old man with a history of hypertension, urolithiasis, and mitral valve regurgitation presented with an incidentally discovered right lower pole renal mass of 3 cm (Fig. 4A). The patient's preoperative creatinine level was 1.4 mg/dL. He underwent transperitoneal laparoscopic partial nephrectomy without vascular control. The mass was identified with laparoscopic ultrasound and resected with the assistance of the Floating Ball. Estimated blood loss was 500 mL. The patient was discharged on postoperative day 2. Histopathologic study revealed clear cell adenocarcinoma with a 7-mm surgical margin.

Laparoscopic Surgical Technique

After laparoscopic renal exposure, the renal artery and vein were exposed to enable vascular control in the event of excessive bleeding during partial nephrectomy. The tumor was characterized with intracorporeal laparoscopic ultrasound. The renal surface surrounding the tumor was exposed, and the capsule around the tumor was scored with electrocautery with a 1-cm margin. The perirenal fat overlying the tumor was left in place. Renal transection was achieved by cutting with cold scissors or a Harmonic Scalpel (Ethicon Endosurgery, Cincinnati, Ohio) after precoagulation of the area with the Floating Ball. The Floating Ball (currently available with a 3-mm-diameter tip) was connected to a radiofrequency (RF) generator and a 1-L bag of 0.9% saline by means of the fluid pathway of the Floating Ball. The RF generator was set to an 80-W coagulating current and the Floating Ball was applied directly to the target tissue. Care was taken to avoid vaporization of the saline. Blockage of the saline channel at the tip may occur during larger resection due to tissue debris. The tip is cleaned to continue saline flow. The collection system was violated in two of four lesions to ensure an adequate surgical margin. The collecting system was closed with intracorporeal suturing. Intravenous methylene blue was administered to confirm the integrity of the renal collection system. The specimen was entrapped in an Endocatch (U.S. Surgical, Norwalk, Conn) sack, removed via a 12-mm trocar site, and sent for frozen section to evaluate the surgical margins.

The renal defect was closed over custom-designed Gelfoam-Surgicel bolsters with interrupted horizontal mattress sutures using 0 Vicryl sutures on a CT1 needle. Suturing was performed only when the renal collection system was violated. Gerota's fascia was closed with interrupted freehand 2-0 Vicryl sutures. A closed-suction 10F Blake drain was then placed through the 5-mm port. This extraction port site was closed using a Carter-Thomason device (Inlet Medical, Eden Prairie, Minn) with a 0 Vicryl suture. Contrast-enhanced CT imaging of the 3 patients (Figs. 2B, 3B, and 4B) on postoperative day 1 confirmed satisfactory results.

COMMENT

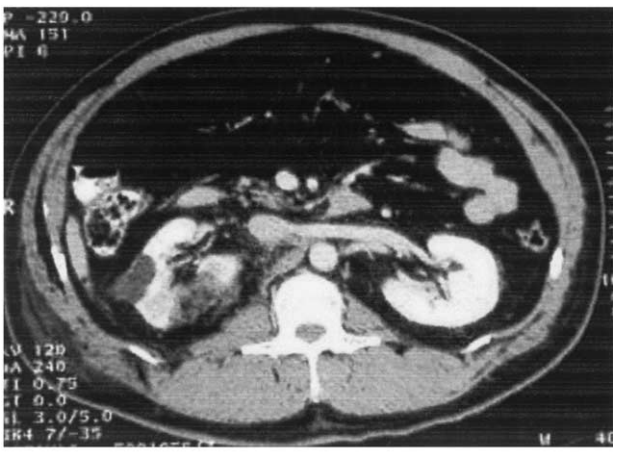
Hemostasis during laparoscopic partial nephrectomy remains a technical challenge. Reported at-

TABLE I. *Tumor characteristics, blood loss, and surgical pathology*

Patient	Lesion Size	Location	OR Time (hr)	Blood Loss (mL)	Histopathology
1	2.6 × 2.4	Lt middle	2.5	150	Papillary renal cell carcinoma
2	2 × 1.2 cm	Rt middle	3.2	150	Angiomyolipoma
	1 × 1 cm	Rt lower pole		300	Angiomyolipoma
3	3 cm	Rt lower pole	3.7	500	Clear cell adenocarcinoma

KEY: *Lt = left; Rt = right; OR = operating room.*

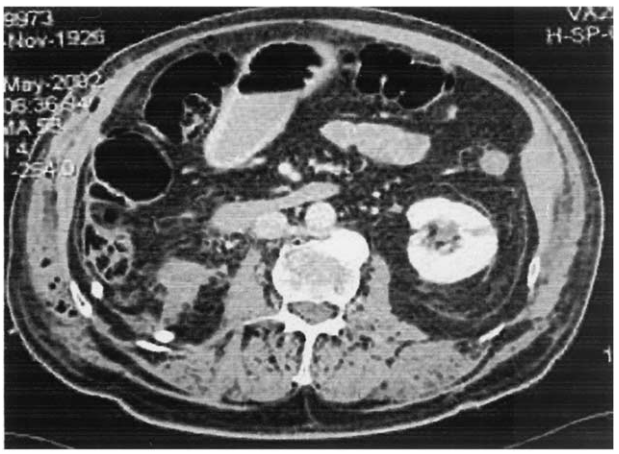
A



B

FIGURE 3. *(A) Preoperative CT scans with the renal tumor, and (B) on postoperative day 1, showing depth of resection in patient 2.*

A



B

FIGURE 4. *(A) Preoperative CT scans with the renal tumor, and (B) on postoperative day 1, showing depth of resection in patient 3.*

tempts for vascular control have included: renal hilum clamping with extracorporeal laparoscopic pedicle clamps (Laparoscopic DeBakey Clamp)[5,6]; intracorporeal pedicle clamp (Bulldog) or vessel loops[7]; plastic cable ties[7]; and Rummel and other forms of tourniquets.[8–11] Other tools that have been used for hemostasis include the argon-beam coagulator, bipolar cautery, neodymium:yttrium-aluminum-garnet laser, ultrasonic scalpel, fibrin glue, fibrin-coated hemostyptic gauze and gelatin sponges,[5,12–14] absorbable fibrin adhesive bandage,[15] and microwave tissue coagulator. Despite the availability of many approaches, the procedure remains difficult. No method has proved effective for large parenchymal transections, except vascular control, which is limited by its inability to achieve renal parenchymal hypothermia laparoscopically.

TissueLink Floating Ball technology consists of saline combined with RF (wet RF). The Floating Ball employs RF energy focused near the tip. Electrical energy is conducted through continuous low-volume saline irrigation and then into the tissue where it is converted into heat by ohmic heat-

ing of the tissue. The saline provides surface cooling to prevent the tissue from exceeding 100°C, which reduces charring and prevents eschar formation and the associated increased tissue impedance. This results in an increase in tissue temperature over greater depths of the treated organ.

At Washington University Medical Center, Dr. Steven Strasberg and associates (personal communication) have performed preliminary clinical and laboratory work with TissueLink Floating Ball–assisted liver resections. Our initial clinical application using the Floating Ball device for renal parenchymal transection has helped control bleeding in four renal lesions. Adequate hemostatic control has permitted good visualization throughout the procedure. The Floating Ball tip is used in light contact with tissue and at an angle of about 60° perpendicular to tissue. The device is applied in a continuous "painting" manner; the depth and width of coagulation are proportional to the duration of energy delivery. When actively bleeding vessels are encountered, the site is treated with the Floating Ball in small circles around the vessel, gradually closing in a spiral manner toward the center. The continuous saline flow requires suction to maintain an appropriate operative field because pooling of liquid at the tip may result in a spread of current and reduce the rate of local tissue heating. The efficacy of the device improves as the clinician gains experience. Inadequate treatment of the tissue before division of the renal parenchyma will result in increased hemorrhage. Parenchymal resection with this technique is clearly slower than resection with vascular control.

Suturing of the renal parenchymal defect was performed in resections in which violation of the renal collection system was found. Suturing without vascular control can result in renewed bleeding that can obscure optimal visibility. However, there is no concern with regard to time restrictions such as that seen with warm ischemia during vascular clamping. On postoperative day 1, CT imaging (Figs. 2B, 3B, and 4B) confirmed the absence of hematoma or urinoma in all patients. Nephron-sparing surgery without calyceal violation for small exophytic tumors does not require suturing or additional hemostatic agents such as the argon-beam coagulator or fibrin sealant.

CONCLUSIONS

Our initial clinical experience suggests that renal parenchymal resection without vascular control during laparoscopic partial nephrectomy is feasible using a water-cooled, high-density monopolar device. Prospective data on more extensive surgical experience are awaited.

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