# Laparoscopic and Robotic Partial Nephrectomy With Controlled Hypotensive Anesthesia to Avoid Hilar Clamping: Feasibility, Safety and Perioperative Functional Outcomes

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**Abbreviations and Acronyms**

ASA = American Society of Anesthesiologists

CH = controlled hypotension

LPN = laparoscopic PN

MAP = mean arterial pressure

PN = partial nephrectomy

RAPN = robotic assisted PN

RENAL = radius or maximal diameter in cm, exophytic/endophytic properties, nearness of tumor to collecting system or sinus in mm, anterior/posterior, hilar tumor touches main renal artery or vein and location relative to polar lines

WIT = warm ischemia time

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**Purpose:** We evaluated the feasibility and safety of laparoscopic and robotic assisted partial nephrectomy with controlled hypotensive anesthesia to avoid hilar clamping and eliminate renal ischemia.

**Materials and Methods:** A total of 60 patients with renal tumors who were candidates for nephron sparing surgery and had no contraindication to hypotensive anesthesia underwent partial nephrectomy without hilar clamping and with controlled hypotension during tumor excision. A total of 40 laparoscopic partial nephrectomies and 20 robotic assisted partial nephrectomies were done. All patients who were candidates for laparoscopic or robotic assisted partial nephrectomy regardless of tumor site, size or growth pattern were included in study. The surgical field was assessed for bleeding and visibility using a numerical rating scale.

**Results:** Median tumor size was 3.6 cm (range 1.8 to 10), median operative time was 2 hours (range 1 to 3.5), median blood loss was 200 ml (range 30 to 700 ml) and median hospital stay was 3 days (range 3 to 8). All margins were negative. The median duration of controlled hypotension with a median mean arterial pressure of 65 mm Hg (range 55 to 70) was 14 minutes (range 7 to 16). No patient required intraoperative transfusion but 4 (6.6%) required transfusion postoperatively. Complications developed postoperatively in 3 patients, ie port site bleeding, hemorrhage and hematoma, respectively. Median preoperative and postoperative serum creatinine was 0.9 and 1.10 mg/dl, respectively. The median preoperative and postoperative estimated glomerular filtration rate was 87.20 and 75.60 ml/minute/1.73 $m^2$, respectively.

**Conclusions:** Controlled hypotension allowed laparoscopic and robotic assisted partial nephrectomy to be done without renal hilar clamping. All procedures were completed safely and perioperative outcomes are encouraging.

**Key Words:** kidney, kidney neoplasms, nephrectomy, robotics, ischemia

Several technical modifications of LPN and RAPN aim to decrease or eliminate warm ischemia, although a limited WIT of 20 to 40 minutes is considered safe to prevent permanent renal damage.[1,2] In any case the safe duration of WIT during PN remains controversial.

Recent publications describe how each minute of ischemia counts and PN without vascular clamping may decrease the risk of acute renal failure and chronic kidney disease.[3–6] To eliminate warm ischemia Gill et al recently reported a novel zero ischemia technique for LPN and RAPN.[7]



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The 2 major components of the technique are 1) selective branch microdissection of the renal artery/vein into the renal sinus and 2) transient, pharmacologically induced decreased blood pressure timed to coincide precisely with excision of the deep part of the tumor.

In our series we used the technique described by Gill et al[7] only for hilar tumors. For peripheral tumors CH was started after complete isolation of the kidney and the tumor and was maintained throughout the resection time. At our institution we have always avoided hilar clamping for PN by performing superselective transarterial embolization preoperatively as the first step of LPN in select cases.[8]

To evaluate the feasibility and safety of LPN and RAPN with CH we enrolled in the study only patients with an ASA score of 1 or 2 without any contraindication to hypotensive anesthesia, including heart disease, severe anemia, coronary artery disease, congestive heart failure, poorly controlled hypertension, increased intracranial pressure, significant cerebrovascular disease, or a low flow state to the liver or kidney. Hypotensive anesthesia is a safe technique that has been used for half a century to decrease bleeding and provide a satisfactory bloodless surgical field. CH is defined as a decrease of systolic blood pressure to 80 to 90 mm Hg, a decrease of MAP to 50 to 65 mm Hg or a 30% decrease of baseline MAP.[9]

We present our initial experience with LPN and RAPN with CH in 60 consecutive patients without hilar clamping and report the perioperative outcome of this technique. We evaluated whether CH makes LPN and RAPN feasible without the need to clamp the renal pedicle.

## MATERIALS AND METHODS

Between December 2010 and June 2011, 60 patients underwent zero ischemia LPN (40) or RAPN (20). Data were collected in a prospectively maintained institutional database. Study inclusion criteria were all patients with a single tumor who were considered candidates for LPN or RAPN regardless of tumor site, size or growth pattern. Renal mass anatomical features were recorded according to the PADUA (preoperative aspects and dimensions used for an anatomical) classification score and the RENAL nephrometry score (see table).[10,11] The mean RENAL score was 7.9 (median 7, range 4 to 10).

The only study exclusion criterion was an anesthesiology contraindication to CH, including congenital heart disease, severe anemia, coronary artery disease, congestive heart failure, poorly controlled hypertension, increased intracranial pressure, significant cerebrovascular disease or a low flow state to the liver or kidney. During the study period 5 patients did not meet inclusion criteria due to an ASA score of greater than 2.

All procedures were done by a single surgeon with extensive experience with LPN and RAPN. Informed consent was obtained from all patients. The study received institutional review board approval.

*PADUA score anatomical aspects and RENAL nephrometry score*

| | No. Pts |
|---|---|
| *PADUA* | |
| Tumor size (cm): | |
| Less than 4 | 36 |
| 4.1-7 | 18 |
| Greater than 7 | 6 |
| Longitudinal location: | |
| Superior | 20 |
| Middle | 22 |
| Inferior | 18 |
| % Exophytic: | |
| Greater than 50 | 12 |
| Less than 50 | 26 |
| Endophytic | 22 |
| Renal rim: | |
| Lat | 38 |
| Medial | 22 |
| Renal sinus involvement: | |
| No | 56 |
| Yes | 4 |
| Urinary collecting system involvement: | |
| No | 51 |
| Dislocated/infiltrated | 9 |
| Face: | |
| Anterior | 37 |
| Posterior | 23 |
| *RENAL* | |
| Radius, tumor size as maximal diameter (cm): | |
| Less than 4 | 36 |
| Greater than 4-less than 7 | 18 |
| Greater than 7 | 6 |
| % Endophytic, exophytic: | 22 |
| Less than 50 | 26 |
| Greater than 50 | 12 |
| Nearness of tumor deepest portion to collecting system or sinus (mm): | |
| Greater than 7 | 28 |
| Less than 7-greater than 4 | 8 |
| Less than 4 | 22 |
| Face: | |
| Anterior | 28 |
| Posterior | 32 |
| Location relative to polar lines: | |
| Entirely above upper or below lower line | 32 |
| Lesion crosses line | 22 |
| Mass greater than 50% across line, crosses axial renal midline or entirely between lines | 6 |
| Tumor abuts main renal artery or vein | 4 |

### Preoperative Evaluation

All patients underwent 1 mm slice computerized tomography with 3-phase acquisition or magnetic resonance imaging scan with 2 to 3 mm cuts to better delimit tumor site, depth and collecting system proximity. For this study serum creatinine was documented preoperatively, at discharge home and 1 month postoperatively. The estimated glomerular filtration rate, calculated using the modification of diet in renal disease formula, was documented preoperatively and at discharge home.