# *Comparison of laparoscopic and open nephrectomy for adult polycystic kidney disease: operative challenges and technique*

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***Objectives:*** *Autosomal dominant polycystic kidney disease an inherited systemic disorder is characterized by the development of multiple cysts in the kidneys and other organs. When nephrectomy is indicated, the laparoscopic approach is challenging due to the massive size of these kidneys. We present our technique and evaluate the surgical outcomes of laparoscopic versus open nephrectomy for patients with such condition.*
***Materials and methods:*** *A retrospective review was done for six laparoscopic and six open nephrectomies performed by two laparoscopic surgeons in two university hospitals between January 2004 and December 2004. Preoperative, intraoperative, and postoperative data are presented. A standard subcostal incision was used for the open cases while for the laparoscopic approach a 3-4-port transperitoneal laparoscopic approach was used to dissect the involved kidney, which is then removed intact or morcellated through pfannenstiel, midline, or expanded port site incision.*
***Results:*** *The laparoscopic patients had a longer operative time with one major complication compared to the open group. On the other hand laparoscopic group achieved minimal blood loss, less narcotic requirement and a shorter hospital stay. No conversion to open required in the laparoscopy group. At a median follow up of 1 year no long-term complications reported in either groups.*
***Conclusions:*** *Laparoscopic nephrectomy for polycystic kidney disease is a feasible and safe alternative to open approach. In addition to low morbidity, other advantages of laparoscopic surgery also achieved in this subset of patients such as the ability to remove the dissected kidney through a small incision, reduced postoperative pain, short hospital stay, and excellent cosmesis.*

**Key Words:** laparoscopy, polycystic kidney, nephrectomy, minimally invasive

## Introduction

Autosomal dominant polycystic kidney disease (ADPKD), an inherited systemic disorder, is characterized by the development of multiple cysts in the kidneys and other organs. It affects approximately four to six million individuals worldwide, and is the fourth most common cause (approximately 10%) of all cases of end stage renal disease.[1] ADPKD patients manifest with several other associated anomalies that include cysts in the liver, pancreas, spleen, and lungs; aneurysms of the circle of Willis (Berry aneurysms) are responsible for death in 8% to 11% of patients with ADPKD.[2] Mitral valve prolapse and colonic diverticula are some of the other anomalies seen in these patients. Mutations in the PKD1 or PKD2 genes give rise to cyst formation.

Affected individuals can present at any age, but more often come to clinical attention (unless there is a family history) after age thirty. Patients who are

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diagnosed before age thirty have a worse renal survival. Although palpation of the abdomen occasionally provides a clue to the presence of polycystic kidney disease, radiographic procedures most often suggest the diagnosis. Flank pain, hematuria, polyuria, nephrolithiasis, urinary tract infections, and hypertension may be part of the syndrome of polycystic kidney disease.

In most cases conservative therapy for symptomatic patients is successful. However, if conservative management fails, native nephrectomy may be indicated.

In the last decades the nephrectomy rate in patients with PCKD has decreased steadily,[3,4] indicating significant progress in the conservative management of PCKD related morbidity. Frequent indications for native nephrectomy in patients with PCKD are the creation of space for a kidney transplant, renal tumor, proteinuria refractory to conservative treatment, recurrent urinary tract infection, hypertension, chronic pain refractory to analgesics and hematuria.

Laparoscopic nephrectomy is now a well-established surgical approach for a variety of renal conditions. It has resulted in better short-term outcomes such as shorter length of stays, reduced postoperative pain, and quicker recovery.[5] Laparoscopic nephrectomy for ADPKD can be challenging due to the massive size of these kidneys and the difficulty in negotiating this large mass with the laparoscopic approach.

The goals of this study are to present our surgical technique and to review our experience with six laparoscopic controlled with six open nephrectomies for ADPKD patients.

## Materials and methods

A retrospective review is made for all laparoscopic nephrectomy of patients with ADPKD that were performed during a 1-year period between January 2004 and December 2004. They were analyzed to identify the surgical outcome and to compare them with unselected group that underwent open nephrectomy for ADPKD during the same period of time. Patients that had hand-assisted laparoscopic nephrectomy or those who had bilateral laparoscopic nephrectomy were excluded. The information gathered included demographics, surgical techniques, total operative time, estimated blood loss, specimen weight, intraoperative complications, total analgesic requirement, total hospital stay, and both short term and long term postoperative complications. Follow up data were obtained from the clinic visits for a median of 1 year postoperatively. Analgesics were converted to intravenous morphine equivalents. Surgeries were performed by one of two principal laparoscopic surgeons at two university hospitals, with or without assistance from fellows or residents. A major surgical complication is defined as one that adversely affects the outcome by prolonging the hospital stay or patient recovery. A minor complication is defined as one that does not affect hospital stay or patient recovery. Statistical analysis was performed using student's t-test, and a p-value of 0.05 was considered statistically significant.

## Laparoscopic nephrectomy for ADPKD

Informed consent was obtained from all patients for laparoscopic nephrectomy and preoperative antibiotic is used routinely. The surgery is done under general anesthesia, then the patient is placed in the lateral decubitus position and the table flexed to open the costo-phrenic angle. The surgeon and the assistant stand anterior to the patient. Video monitors are located at the head of the operating table on both sides. A 15-mm Hg carbon dioxide pneumoperitoneum is established with a Veress cannula that is placed at the apex of the umbilicus or using a 12-mm Optiview direct laparoscopic access technique. Two or three additional ports of varying size (5 mm to 12 mm) in an arc-like shape are placed under direct vision in the subxiphoid region, iliac fossa, and flank, as required, Figure 1.

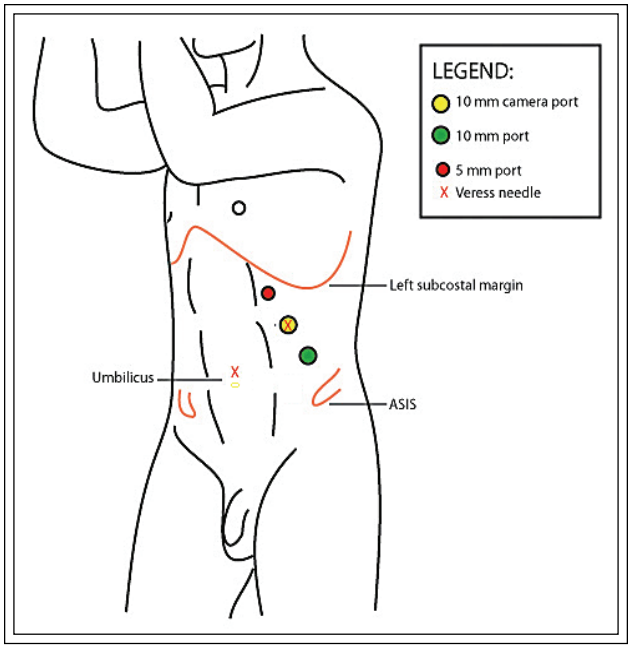


**Figure 1.** Port placement for left sided laparoscopic nephrectomy.

Additional 5-mm port is used at the subxiphoid region to retract the liver for right-sided nephrectomy.

A 0° -viewing 10-mm laparoscope is inserted initially for ports insertion, then exchanged with a 30°-viewing 10-mm laparoscope and used through the procedure. On the right side, the colon is mobilized toward the midline and the duodenum is kocherized to expose the kidney. On the left, the descending colon and spleen are mobilized medially to optimize exposure of the entire kidney. It is important to be aware of the location of the mesocolon, spleen, pancreas, and gallbladder, because they are frequently adherent to the cystic kidney. Dissection of the kidney is carried out carefully to minimize cyst puncture that may lead to spillage and subsequent peritonitis. To help in its identification, the lateral border of the inferior vena cava (on the right) can be used as a guide to the right renal vein. The ureter identified at the pelvic brim (right or left), can also be used as a landmark and followed proximally to the hilum. If necessary, extra 5-mm ports were inserted and used to negotiate the large polycystic kidney. Both the artery and ureter are divided after being controlled by multiple titanium clips. The renal vein is divided using EndoGIA autosuture device. The adrenal gland is preserved whenever possible.

The kidney is then extracted intact through midline or pfannenstiel incision according to the surgeon preference or placed in a laparoscopic bag and morcellated with mechanical forceps and extracted piecemeal through a 12-mm port site enlarged to a median of 2 cm (range 2 to 4). The extraction incision is closed and the pneumoperitoneum re-created to inspect for hemostasis. We irrigate the abdomen with 2 L of sterile saline to wash away any residual cyst fluid. The abdomen is deflated, and the 10-12 mm trocar incisions are closed under direct vision with absorbable sutures using the Carter-Thomason device. The 5-mm ports are closed only at the skin level.

## Results

Throughout the year of 2004 six laparoscopic nephrectomies were performed for patients with ADPKD. The indication for surgery in the laparoscopic group was preparation for future renal transplant (to create space) in four patients, pain and recurrent urosepsis in one patient each. For the open group the indications were preparation for future transplant in three patients, painful kidney in two and recurrent hematuria requiring blood transfusion in one. No significant differences were found between the patient groups with respect to sex, age, anesthesia risk (ASA), or body mass index, Table 1. All but one patient in each group were dialysis dependent.

The intraoperative parameters are summarized in Table 2 that shows longer operative time in the laparoscopy group with a mean of 179 minutes (113-240), compared to a mean of 137 minutes (90-190) in the open group. The estimated blood loss was statistically lower in the laparoscopy group compared to the open one [75 ml (50-100) and 339.2 ml (100-650) respectively]. Two midline and one port site extracted kidneys were morcellated and in the remaining three patients the kidneys were removed intact (one midline and two Pfannenstiel site). The mean incision size

TABLE 1. **Preoperative parameters**

| Characteristic | Open | Laparoscopic | P value |
|---|---|---|---|
| Number of cases (n) | 6 | 6 | |
| Gender | | | |
| Male | 4 | 4 | ns |
| Female | 2 | 2 | ns |
| Mean age (years) | 52 (43-64) | 52 (42-67) | ns |
| Median ASA | 3.0 | 3.0 | ns |
| Mean BMI | 26 (23.2-27.7) | 29 (24.1-38) | ns |
| Preoperative dialysis (n) | 5 | 5 | ns |
| Operative side (n) | | | |
| Left | 3 | 1 | ns |
| Right | 3 | 5 | ns |

ns – not significant; ASA – American Society of Anesthesiologists classification; BMI – body mass index; n – number; () – numbers in parentheses are the range

TABLE 2. **Intraoperative parameters**

| Characteristic | Open | Laparoscopic | P value |
|---|---|---|---|
| Mean duration of procedure (min) | 137 (90-190) | 179 (113-240) | 0.12 |
| Mean estimated blood loss (ml) | 339.2 (100-650) | 75 (50-100) | 0.03 |
| Mean size of extraction incision (cm) | na | 10.4 (8-17) | na |
| Extraction type (n) | | | |
| Pfannenstiel | na | 2 | na |
| Midline | na | 3 | na |
| Port site | na | 1 | na |
| Specimen weight (gm) | 2998 (2020-6000) | 1059 (460-1955) | 0.01 |
| Intraoperative complications (n) | | | |
| Minor | 0 | 0 | ns |
| Major | 0 | 1 | ns |

ns – not significant; na – not applicable; n – number; () – numbers in parentheses are the range

for the intact specimens was 10.4 cm (8-17). With regards to the intraoperative complications there was only one major complication in the laparoscopy group, perforation of the gallbladder with the Veress needle requiring emergent laparoscopic cholecystectomy. This complication is reflected in the total operative time and hospital stay which was the longest of all the 12 patients included in this study (240 min and 11 days respectively). There were no intraoperative complications in the open group and no patient from the laparoscopy group required open conversion.

No patient in either group required a blood transfusion. With regards to postoperative parameters, summarized in Table 3, no difference noticed in the total hospital stay among the comparison groups. This can be attributed to the longer stay needed for one of the laparoscopy patients who had the above mentioned complication, and a separate analysis excluding this patient would show a mean hospital stay in the laparoscopy group of 2.5 days versus 5 days in the open counterpart. Analgesic requirements were lower in the laparoscopy group compared to the open one [98.5 mg (21-240) versus 159 mg (27-278) respectively]. At a median 1 year follow up there were no short or long term complications recorded in the open group while there was one myocardial infarction managed medically in the same patient mentioned above in the laparoscopy group.

## Discussion

The surgical options for patients with ADPKD are evolving with the introduction of minimally invasive surgical techniques. Open nephrectomy is curative; however, the morbidity of the procedure is considerable.[6,7] This is attributed to the fact that these

TABLE 3. **Postoperative parameters**

| Characteristic | Open | Laparoscopic | P value |
|---|---|---|---|
| Mean length of stay (days) | 5 (3-8) | 4.7 (2-11) | ns |
| Mean analgesic requirement (mg morphine equivalents) | 159 (27-278) | 98.5 (21-240) | 0.32 |
| Mean first ambulation (day) | 2 (1-3) | 2.8 (1-8) | ns |
| Mean first full diet (day) | 2.8 (2-4) | 3.2 (2-8) | ns |
| Postoperative complications (n) | | | |
| Minor | 0 | 0 | ns |
| Major | 0 | 1 | ns |

ns – not significant; n – number; () – numbers in parentheses are the range

patients have markedly higher surgical risk because of their renal failure and multisystem disease and physical difficulties due to the size of the kidney. Similarly the postoperative course is often protracted, as is the wound healing. In 1973, Bennett et al[6] reported a morbidity rate of 38% and a mortality rate of 3% in 31 patients who underwent bilateral open nephrectomy for ADPKD. Since then, many advances in anesthetic and operative techniques, as well as in perioperative patient management, have occurred, which have improved the results significantly.

Currently, laparoscopy is a well-established surgical approach for a variety of renal conditions. It has resulted in better short-term outcomes such as shorter length of stays, reduced postoperative pain, and quicker recovery. Laparoscopic cyst decompression and marsupialization have been widely reported in patients with residual renal function but in those with end-stage renal disease requiring renal replacement therapy, it is generally accepted that nephrectomy be undertaken for cyst-related infections, intracystic hemorrhage, hematuria, refractory hypertension, and symptomatic relief of pain.

Laparoscopic nephrectomy has been performed for ADPKD, and reported in series with small numbers. Dunn et al[8] published the first report dedicated to the laparoscopic removal of large kidneys in patients with ADPKD. In this study an excellent perioperative results achieved and they concluded that laparoscopic nephrectomy offers an effective alternative to open nephrectomy with benefits including minimal intraoperative blood loss, minimal postoperative pain, brief hospital stay, and rapid convalescence. Similarly Bendavid et al[5] reported their experience in 22 laparoscopic nephrectomies for patients with ADPKD, the median kidney size was 22 cm (8 cm-50 cm), median operative time was 255 min (95 min-415 min), with no morbidities. They had 18% intraoperative complications, and 32% postoperative ones, with a conversion rate of 18%. They concluded that laparoscopic nephrectomy for autosomal dominant polycystic kidney disease is a safe procedure, providing patients with a short hospital stay but with a relatively high complication and conversion rates.

Hand-assisted laparoscopic nephrectomy is another option for this condition. It is more applicable for bilateral nephrectomy to minimize the operative time and the technical challenge associated with pure laparoscopic nephrectomy.[9,10]

In our limited study although it takes longer to complete it, the laparoscopic nephrectomy group achieved minimal blood loss, minimal analgesic requirement and relatively shorter hospital stay. The laparoscopic approach provides an alternative to open nephrectomy for patient with ADPKD but with potential risks. Injury to the intraabdominal organs is a concern considering the relatively limited abdominal working volume due to the enlarged kidney. Some authors advocate reducing the kidney volume intracorporeally by cyst puncture and aspiration,[5] and others found this hazardous as it can cause peritonitis-like picture with significant abdominal pain lasting 1-2 weeks.[10] Limited abdominal space in these patient also make it even hazardous to use the Veress needle to gain the initial access and a controlled visual trocar placement is recommended. The longer operative time in laparoscopic nephrectomy is also reported by others[5,8] and is not insignificant in places with limited resources, but this should be balanced with the result of shorter hospital stay in this group. Additionally this study reflects our initial experience and the operative time can be improved with experience as it is with other laparoscopic procedures.

The operative technique differs in certain aspects when comparing laparoscopic ADPKD nephrectomy to standard laparoscopic radical nephrectomy. The hilum is approached in a standard fashion, however negotiating the upper pole including the adrenal gland as well as the posterior-lateral portion of the involved kidney is challenging due to the large size of the kidney itself and therefore the limited working space. In such situation, use of hand-assisted device may be beneficial. To facilitate the procedure we encourage use of additional 5-mm ports when necessary to "retract" portions of the large polycystic kidney mass. We particularly find the Jarit Padron Endoscopic Exposing Retractor (PEER)® (J. Jamner Surgical Instruments, Inc, Hawthorne, NY, USA) useful for this purpose. Certainly, we would recommend surgeons have adequate laparoscopic experience before embarking upon this advanced laparoscopic procedure.

## Conclusion

In addition to the available evidence, our experience further support laparoscopic nephrectomy as a safe and feasible alternative to open approach in patients with ADPKD requiring nephrectomy. Considering the initial learning curve, further experience will prove the ability to manage more complex large kidneys in a similar minimally invasive technique. We present technique pointers to facilitate performing such procedure in this challenging patient population. □

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