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ORIGINAL ARTICLE

Laparoscopic nephrectomy for polycystic kidney: comparison of the transperitoneal and retroperitoneal approaches

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Abstract

Purpose To evaluate and compare perioperative outcomes in patients undergoing either transperitoneal (TP) or retroperitoneal (RP) laparoscopic nephrectomy for autosomal dominant polycystic kidney disease (ADPKD).

Methods All patients with ADPKD who underwent unilateral laparoscopic nephrectomy between 2000 and 2012 in two academic departments were retrospectively included. The perioperative parameters were compared between the TP and RP groups.

Results A total of 82 patients were included, 43 patients in the TP group and 39 in the RP group. The patients' characteristics were similar between TP set and RP set, except for the time from dialysis onset to nephrectomy ($p = 0.02$). Complication rates (25.6 vs 33.3 %, $p = 0.44$), transfusion rates (11.6 vs 20.5 %, $p = 0.27$) and conversion to open surgery (4.6 vs 7.7 %, $p = 0.56$) were similar between the TP and RP groups, respectively. Operative time was shorter for TP procedures (171.6 vs 210.5 min, $p = 0.002$), but there was no difference between the two approaches after 20 surgeries ($p = 0.06$). Patients in TP group had a shorter length of hospital stay (5.3 ± 1.9 vs 7.2 ± 2.5 days, $p = 0.002$). However, there was a trend towards shorter return of bowel function in the RP group (2.1 ± 0.9 vs 2.4 ± 0.8 days, $p = 0.09$).

Conclusion TP and RP laparoscopic nephrectomies provide good outcomes in patients with ADPKD. The choice of a TP route could decrease the length of hospital stay and the operative time during the beginning of the learning curve period.

Keywords Laparoscopy · Polycystic kidney disease · Nephrectomy · Transperitoneal · Retroperitoneal

Introduction

Autosomal dominant polycystic kidney disease (ADPKD) is one of the most common aetiologies of end-stage kidney disease [1] and leads to dialysis or renal transplantation in 50 % of 60-year-old patients [2]. Nowadays, surgical treatment by nephrectomy is accepted for two main indications: symptoms related to the cysts (pain, infection, haematuria, bleeding, nephrolithiasis or high blood pressure) and preparation for renal transplantation [3, 4]. This surgery is performed in many centres for over 20 years, and more recently, the development of the laparoscopic approach has proven its safety and feasibility compared to the initial open approach [5]. Two laparoscopic routes have been described for removal of polycystic kidneys: transperitoneal (TP) or retroperitoneal (RP). The TP approach has been reported in several series [6, 7, 8]. The RP approach is described in only two studies [9, 10] and less known. However, laparoscopic RP approach has demonstrated some advantages in terms of hospital stay and return of bowel function in other kidney surgeries like partial nephrectomy for renal tumours [11]. To our

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knowledge, both approaches for ADPKD laparoscopic nephrectomy have never been compared.

The aim of our study was to evaluate and compare the TP and RP approaches for nephrectomy in ADPKD patients.

Materials and methods

Population

We retrospectively reviewed the charts of all consecutive patients who underwent unilateral laparoscopic nephrectomy for ADPKD in two academic departments of urology in tertiary medical centres. In the first centre, nephrectomies were performed by one surgeon (KB) using the TP approach, and in the second centre, one surgeon (XG) performed all the nephrectomies using the RP approach. Both surgeons had performed >30 laparoscopic procedures before the beginning of the study. A preoperative CT scan was systematically carried out for all patients. Collected demographic data included: age, gender, BMI (kg/m^2), ASA score [12], kidney craniocaudal size (cm), dialysis and time from the onset of dialysis, nephrectomy indications and the kidney weight.

Reviewed perioperative data were: operative time (minutes), conversion to open surgery, perioperative transfusion, length of hospital stay and return of bowel function. Complications were graded according to the Clavien–Dindo classification [13].

### Surgical technique

Transperitoneal approach

The surgical technique of TP laparoscopic nephrectomy for polycystic kidney used in this group has been previously described [8]. Briefly, patients were positioned on the lateral flank position. An open laparoscopy on the umbilicus was used (Fig. 1a). Three more ports were placed: a 5-mm

port under the subcostal margin on the midclavicular line, a 12-mm in the iliac fossa and a 5-mm just inferior to the xiphoid to retract the liver in case of nephrectomy on the right side. The first step was the mobilization of the colon to expose the anterior surface of the kidney. Dissection of the vena cava was not performed. At the lower pole of the kidney, the gonadal vein was dissected. Gerota's fascia was then incised to find the plane between the psoas muscle and the kidney. At this time, an additional 5-mm port was inserted in the flank to lift the kidney and expose the renal hilum. The ureter was identified and sectioned between two 5-mm Hem-o-lok® clips. The renal pedicle was progressively dissected until the renal vein was exposed. The renal artery could be viewed behind the vein in all cases. The artery was secured with 10-mm Hem-o-lok® clips and cut. The renal vein was sectioned between three 12-mm Hem-o-lok® clips. The kidney was completely mobilized in the simple nephrectomy plan. The adrenal gland was spared in all cases. The kidney was removed using a 7-cm Pfannenstiel incision. No retrieval bag was used for the extraction due to the increased size of the polycystic kidneys. If an en bloc extraction could not be made, the specimen was cut into several pieces through the incision using cold scissors.

Retroperitoneal approach

The patient was placed in lumbotomy position. The table was maximally flexed. A horizontal incision was performed under the tip of the 12th rib. An open laparoscopy was performed allowing to enter in the RP space by dissection with scissors. A 12-mm port was introduced at the corner of 12th rib and paraspinal muscle for camera and to check out the good position in the RP space (Fig. 1b). This space was then inflated with CO_2 to a pressure of 12 mmHg, and the flow rate of filling was gradually increased to three litres per minute (Fig. 2). Two other ports were introduced under view control: a 10-mm port facing the tip of the 12th rib and a 5-mm port at the posterior axillary line facing the tip of the 11th rib. After the three ports setting, the 10-mm port allowed the introduction of camera for next stage of

Fig. 1 Position of laparoscopic ports for the transperitoneal (**a**) and retroperitoneal (**b**) approaches
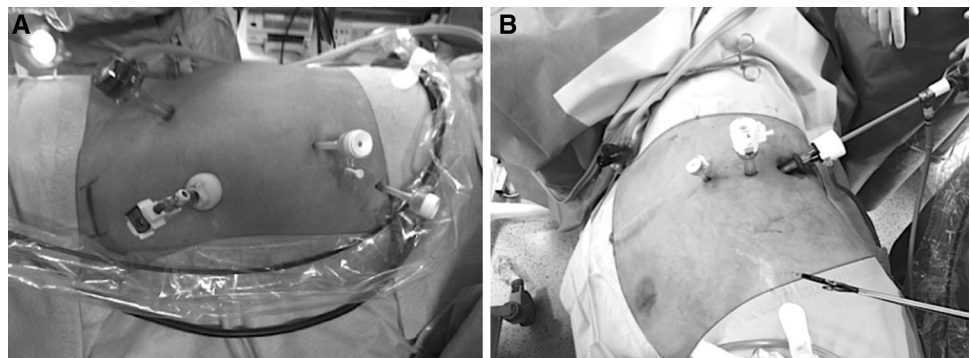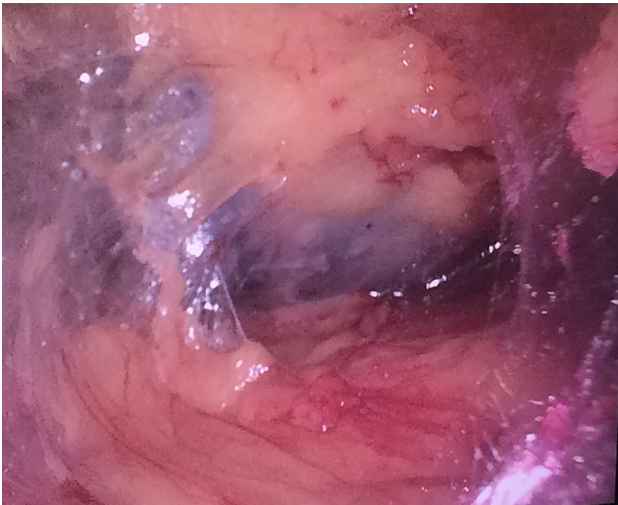
Fig. 2 Retroperitoneal space during insufflation

the surgery. The psoas muscle was identified and was followed on its inner edge containing the fatty components of the renal space in front.

In each case, the artery was horizontally disposed because of the kidney weight, taking an inward direction. This had two consequences: Its identification was more difficult than for a normal kidney, and it made it harder to control. Artery and vein were ligated with three haemoclips (Hem-o-lok®).

The posterior part was fully released up to the kidney upper pole. The lower pole was released and the ureter was found, clipped and cut between two clips. The anterior face of the kidney was released up to the upper pole sparing the adrenal gland.

The renal volume was then reduced by collapsing cysts with suction device. A new incision of three to five centimetres joining the two posterior ports was then performed to remove the kidney. The quality of the haemostasis was then checked out. Ports were removed after pneumoperitoneum exsufflation. A drain was left in the resection bed.

Statistical analysis

Quantitative data were expressed as means (±standard deviation) and qualitative data as numbers and proportions. Operative and perioperative outcomes were compared between both approaches. Operative time was compared between the two approaches according to the number of performed cases for each surgeon in order to evaluate the learning curve of both techniques, and linear regression was performed to show trends.

Quantitative values were compared with Student's t test. Qualitative values were compared with the χ^2 test or Fisher's exact test. Analyses were performed using the JMP Pro 10 (SAS Institute, Cary, NC). $p < 0.05$ was considered as statistically significant.

Results

Patients' characteristics

Between 2000 and 2012, 82 patients were included: 43 in the TP group and 39 in the RP group. Mean age was 54.9 ± 1.1 years in the TP group and 53 ± 1.1 years in the RP group ($p = 0.21$), and in both groups most of the patients had an ASA score of 3. Transplantation preparation was the most common indication for the nephrectomy in both cohorts. The only difference between the demographic characteristics of the two groups was the time from the dialysis onset that was higher in the RP group than in TP group (20.1 ± 3 vs 9.7 ± 3 months, $p = 0.02$, respectively) (Table 1).

Comparison of perioperative outcomes

Perioperative outcome comparison showed a significant longer operative time in the RP group than in the TP group (210.5 ± 59.7 vs 171.6 ± 49.2 min, $p = 0.002$, respectively) (Table 2). Learning curve study showed in both groups an improvement in the operative time according to the number of performed cases. Operative time decreased faster in the TP group. After 20 surgeries, the operative time was not different between the two approaches (Table 2; Fig. 3).

Hospital stay was longer in the RP group (7.2 ± 2.5 vs 5.3 ± 1.9 days, $p = 0.002$, respectively). There was no difference in terms of total complications rate between the two groups (25.6 % in the TP group vs 33.3 % in the RP group, $p = 0.84$) (Table 2). Transfusion rates were not different between the two approaches. Detail of complications is reported in Table 3. There was a trend towards shorter time from nephrectomy to renal transplantation in the TP group (7.6 ± 2.6 vs 14.7 ± 2.5 months, $p = 0.05$). In contrast, the time to return of bowel function tended to be decreased in the RP group (2.1 ± 0.9 vs 2.4 ± 0.8 days, $p = 0.09$).

Discussion

Nephrectomy for ADPKD has spread significantly over the past few years. This surgery is usually performed in urologic transplantation academic centres after collegial decision including nephrologist and urologist. The important rate of complications inherent to removal of polycystic kidney has led to develop medical or less invasive treatment options of cyst complications (infection, high blood

Table 1 Patients' demographic characteristics

	Transperitoneal ($N = 43$)	Retroperitoneal ($N = 39$)	p value
Mean age (years), mean ± SD	54.9 ± 1.1	53 ± 1.1	0.21
Gender, n (%)			0.37
Female	20 (46.5 %)	22 (56.4 %)	
Male	23 (53.5 %)	17 (43.6 %)	
Body mass index (kg/m^2), mean ± SD	24.2 ± 0.6	24.5 ± 0.6	0.73
ASA score, n (%)			0.62
2	6 (14 %)	8 (20.5 %)	
3	37 (86 %)	31 (79.5 %)	
Kidney size (cm)	22.5 ± 4.1	23.4 ± 4.8	0.45
Patients on dialysis, n (%)	34 (79.1 %)	33 (84.6 %)	0.51
Time from dialysis onset to nephrectomy (months), mean ± SD	9.7 ± 3	20.1 ± 3	0.02
Indication for nephrectomy, n (%)			0.44
Preparation for transplantation	33 (76.7 %)	27 (69.2 %)	
Symptoms related to the kidney	10 (23.3 %)	12 (30.8 %)	

Table 2 Outcomes of transperitoneal versus retroperitoneal approaches

	Transperitoneal ($N = 43$)	Retroperitoneal ($N = 39$)	p value
Operative time (min), mean ± SD			
Total population	171.6 ± 49.2	210.5 ± 59.7	0.002
$n < 20$ surgeries	188.2 ± 60.9	244 ± 61.9	0.007
$n > 20$ surgeries	157.1 ± 30.8	176 ± 32	0.06
Conversion to open surgery, n (%)	2 (4.6 %)	3 (7.7 %)	0.56
Total perioperative blood transfusion, n (%)	5 (11.6 %)	8 (20.5 %)	0.27
Return of bowel function (days), mean ± SD	2.4 ± 0.8	2.1 ± 0.9	0.09
Hospital stay (days), mean ± SD	5.3 ± 1.9	7.2 ± 2.5	0.002
Kidney weight (g), mean ± SD	1322 ± 83.3	1150 ± 90.6	0.17
Time from nephrectomy to renal transplantation (months), mean ± SD	7.6 ± 2.6	14.7 ± 2.5	0.05
Postoperative complications, n (%)	11 (25.6 %)	13 (33.3 %)	0.44
Major postoperative complications (Clavien grade ≥3), n (%)	5 (11.6 %)	5 (12.8 %)	0.87

pressure, pain, lithiasis) instead of surgery [14, 15, 16]. However, nephrectomy is still required in up to 18.5 % of patients with ADPKD when medical treatment failed [17]. To attempt to rule out any suspicious lesion before surgery, a CT scan was systematically carried out. In this series, no patient had such lesions. Moreover, the incidence of cancer in these patients is rare [18].

Laparoscopic nephrectomy is nowadays the most common approach for patients with ADPKD thanks to the decrease in hospital stay, blood loss, pain and the improvement of cosmetic aspects in several series or meta-analysis as compared to the open approach [5, 8, 19]. In case of laparoscopic surgery, RP approach has demonstrated some advantages in terms of operative time, hospital stay and return of bowel function in partial nephrectomy for small and posterior tumours [11]. Similarly, Dols et al. [20] showed in a randomized trial that hand-assisted

retroperitoneal living donor nephrectomy decreased operative time and provided a similar quality of life as compared to the TP group.

To the best of our knowledge, we report here the largest series of RP nephrectomy for ADPKD and the first study comparing RP and TP approaches. We showed that both approaches were safe and feasible without difference in terms of complication rate, but with shorter operative time and hospital stay in the TP group.

RP approach, by avoiding bowel mobilization, provides a more direct access to the kidney and the renal hilum [11] and decreases the risk of visceral complications. Indeed in our study, we reported in the TP group one splenic injury, one bowel tear and one pleural tear and none in the RP group. These arguments in favour of RP approach were previously reported in different studies in renal surgery [11, 21]. Desai et al. [19] in a series of 21 TP nephrectomies for
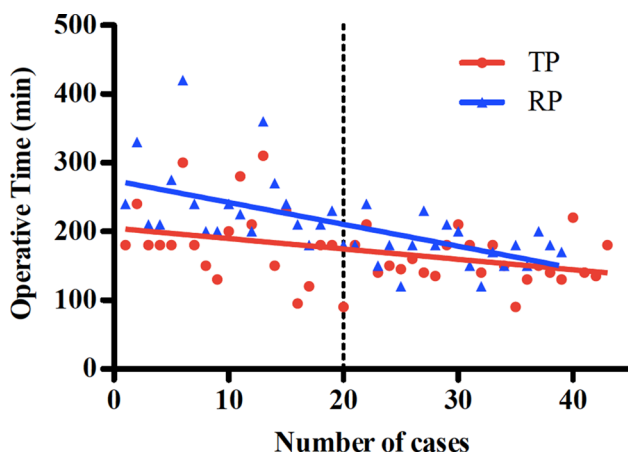
Fig. 3 Learning curve concerning operative time. *Lines* represent the linear regression of the operative time function of the number of performed cases; in *red*: transperitoneal approach (*TP*); in *blue*: retroperitoneal approach (*RP*). The *y-axis* represents the operative time, and the *x-axis* represents the case number

ADPKD reported more difficulties in surgery dissection on patients with bowel adhesions. Moreover, we found in this study a trend towards a shorter return of bowel function in the RP group. These observations suggest that RP approach could be preferred to TP for ADPKD patients with history of abdominal surgery and risk of intra-abdominal adhesions. We can also consider that one advantage of the retroperitoneal nephrectomy is to keep intact the transplantation space. Nevertheless, no difficulty was noticed during transplantation in patients who underwent a TP nephrectomy.

Length of hospital stay was significantly higher in the RP group than in the TP group. This result was unexpected as RP approach for laparoscopic kidney surgery usually decreases hospitalization stay [22, 23]. However, it may be related to the fact that the experience of RP approach for ADPKD began 6 years before TP and because two of the 39 (5.1 %) RP patients had severe complications with a hospital stay over 3 weeks. Moreover, length of hospital stay and time from the onset of dialysis differences may be related to a centre effect.

In our study, although the operative time was lower in the TP group than in the RP group, it was similar and began to plateau in both groups after 20 cases, indicating that the learning curve was longer in the RP group. Similarly, Eng et al. [24] reported the existence of a learning curve in hand-assisted laparoscopic nephrectomies for ADPKD, showing that there was a trend for a shorter operative time when surgeons performed more than ten procedures as compared to those who performed less than five. The higher operative time observed in the RP group during the first cases may be related to a lower experience for the RP approach in kidney surgeries at the beginning than for the TP which is mainly performed in other kidney surgeries (tumours, living donor, pyeloplasty). As each type of surgery was performed by only one surgeon, results may be influenced by their expertise. Another important explanation was the frequent inflammatory adhesions of cysts in a smaller operative space during RP approaches, which is completely different from the RP approach for tumours or living donor nephrectomy.

Despite those results, several study limitations have to be mentioned. First, as in any retrospective analysis, there was inherent risk of bias even if data were collected from standardized databases. The kidney size was not collected in our database. Blood loss was only evaluated by the rate of transfusion. In fact, RP approach used an aspiration of the cyst which overestimates blood loss during the surgery and could not allow any comparison between both TP and RP approaches. Moreover, we did not use the difference between pre- and postoperative rate of haemoglobin because this was not usable for patients undergoing dialysis, haemoglobin rate being largely modified by haemoconcentration

Table 3 Types of complications

	Transperitoneal (N = 43)	Retroperitoneal (N = 39)	p value
Total, n (%)	11 (25.6)	13 (33.3 %)	0.44
Type of complication, n			
Bowel injury	1	0	
Splenic tear	1	0	
Pleural tear	1	0	
Spontaneous closure of the arm arteriovenous fistula	2	4	
Retroperitoneal haematoma	0	2	
Parietal haematoma	1	1	
Necrotizing fasciitis	0	1	
Respiratory insufficiency	1	0	
Fever	2	0	
Blood transfusion without clinical bleeding symptoms	2	5	

or haemodilution [25]. We can also consider that the small number of performed cases was a limitation of our study. Nevertheless, to the best of our knowledge, it is the largest series of RP nephrectomy for ADPKD, and this is the first that compares two different laparoscopic approaches for this surgery. Finally, it should be noted that these series comprised the first cases of each surgeon and therefore compared the learning curve of the two techniques. It could be interesting to assess the safety and efficacy of the two approaches further in the surgeons' experience.

Conclusion

TP and RP laparoscopic nephrectomies provide good outcomes in patients with ADPKD. Operative time was longer for the RP route for the initial 20 cases and was similar thereafter. The length of stay was shorter for TP approach. The return of bowel function tended to be faster in the RP group. Further prospective randomized controlled trials are needed to confirm our findings and to determine which approach should be favoured.

Authors' contribution T. Benoit contributed to protocol/project development, data collection or management, data analysis and manuscript writing/editing. B. Peyronnet was involved in protocol/project development, data collection or management, data analysis and manuscript writing/editing. M. Roumiguie contributed to data collection or management and data analysis. G. Verhoest was involved in data collection or management. J. B. Beauval contributed to manuscript writing/editing. A. Delreux contributed to protocol/project development. D. Chauveau was involved in protocol/project development. B. Malavaud contributed to protocol/project development. A. Manunta was involved in protocol/project development. M. Soulié contributed to protocol/project development. P. Rischmann was involved in protocol/project development. K. Bensalah contributed to protocol/project development and manuscript writing/editing. X. Gamé was involved in protocol/project development and manuscript writing/editing.

Compliance with ethical standards

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