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Comparative Analysis of the Short Term Results of Retroperitoneoscopic and Open Nephrectomies for Non-Oncological Kidney Diseases

Nazarov Dj. A., Mukhtarov Sh. T., Akilov F. A., Nasirov F. R., Ayubov B. A., Bakhadirkhanov M. M., Nuriddinov Kh. Z.

Republican Specialized Scientific-Practical Medical Center of Urology, Tashkent, Uzbekistan

Abstract **Background.** With increasing acceptance of laparoscopic, retroperitoneoscopic and robotic procedures in urology over the last three decades, there is an ongoing discussion about the comparative outcomes of these procedures. **Purpose:** To report outcomes of retroperitoneoscopic nephrectomy (RPN) versus standard technique of open nephrectomy (ON) for various non oncological kidney diseases. **Material and Methods:** Clinical data of 347 patients who underwent nephrectomy from January 2019 to December 2019 were analyzed retrospectively. All patients were divided into 2 groups corresponding the surgical procedure. First group included 180 patients who underwent retroperitoneoscopic (RP) nephrectomy and second group consisted from 167 patients who underwent open nephrectomy. In both groups, the parameters of clinical outcome such as total blood loss, incision length, duration of surgical procedure, doses of nonsteroidal anti-inflammatory drugs used after surgery for pain relief and postoperative hospital stay are analyzed. We also assessed postoperative complications and classified. **Results:** The median amount of estimated blood loss was significantly lower ($p < 0.001$) in RP nephrectomy group 10 (10-400, IQR-40) mL in RPN group and 100 (25-400; IQR-100) mL in ON group). The median incision length was 60 mm (40-100 mm; IQR – 30) vs. 150 mm (100–230 mm: IQR – 30), and the median postoperative hospital stay was 2 days (1-12 days; IQR-1) vs. 5 days (2–14 days; IQR-2), and doses of analgesic medication requirement were 150 mg (0-375 mg; IQR-150) vs. 225 mg (0–1025 mg; IQR-225) for RPN and open nephrectomy respectively. The median operative time was 90 min (20-210 min; IQR - 45) for RPN and 80 min (60-180 min; IQR - 15) for ON, which didn't significantly differ ($p = 0.711$). *Complications.* In ON group in 33 (19,76%) patients we observed postoperative complications. Among them 15 (8.98%) patients developed incision site infection, in 5 (2.99%) patients there was bleeding from retroperitoneal drainage, which required to increase in draining time. Postoperatively 5 (2.99%) patients had bowel dysfunction, in 1 (0.6%) patient developed hospital acquired pneumonia, in 2 (1.2%) patients - myocardial infarction and acute cerebrovascular accident, in 3 (1.8%) patients – sepsis, in 1 (0.6%) patient – intestinal fistula. 1 (0.6%) patient died due to sepsis syndrome and multiorganal failure. In RPN group in 16 (8.89%) we observed postoperative complications. Among them 7 (3.9%) patients developed incision site infection, in 2 (1.11%) patients there was bleeding from drainage, in 6 (3.33%) patients had bowel dysfunction. 1 (0.55%) patient developed mild brachial plexopathy, which treated by the administration of analgesia and muscle relaxers. **Conclusions:** Short-term results demonstrate that retroperitoneoscopic nephrectomy has the same success rates as open, - thoracolumbothomic approach, but morbidity and complication rate are significantly lover. These findings suggest that RPN has the potential to replace open surgery as the standard for treatment of majority of kidney cases.

Keywords Retroperitoneoscopic, Nephrectomy, Morbidity

1. Introduction

The nephrectomy procedure was introduced to the practice of surgeons in XIX century. Based on this experience, the approaches, technical details, steps of the operation has been changed and modified and has become a standard all over the world for the treatment of different renal diseases [1,2].

In 1990, Clayman et al. [3] performed the first laparoscopic nephrectomy and this method popularized worldwide. The technical difficulties of accessing the retroperitoneal space and the impossibility to create an effective and enough large pneumoretroperitoneum were overcome in 1992 by the introduction of the balloon dissection technique by Gaur [4]. This new approach then was modified and enabled the performance of different retroperitoneoscopic (RP) procedures [5,6]. But, despite the

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technical feasibility, current use of the retroperitoneal approach is not so much popular among urologists. In this study, we have comparatively evaluated our experience with the RP and with open nephrectomy (ON) performed in our clinic. These two groups have been balanced in terms of indications (table 1) and compared with respect to operative time, morbidity, blood loss, dose of analgesic use, postoperative mean visual analogue pain score (at third day) and postoperative hospital stay.

2. Material and Methods

Clinical data of 347 patients who underwent nephrectomy from January 2019 to December 2019 in Republican Specialized Scientific-practical Medical Center of Urology were analyzed retrospectively. The most common indication for both groups were scarred (nonfunctioning) kidney. Patient with suspected or confirmed malignancy were excluded from the analysis. Preoperative management included transabdominal ultrasound and urinalysis with culture, KUB film and intravenous urography or/and computed tomography (CT) urography, serum creatinine, complete blood count and basic metabolic panel. The American Society of Anesthesiologists (ASA) grading system was used to assess the patient's physical condition and surgical risk.

All patients were divided into 2 groups corresponding the surgical procedure. Patient selection was based upon referral, requesting either a laparoscopic or an open surgical approach, or depending on the previous surgical procedures and the complexity of the clinical case. First group included 180 patients who underwent retroperitoneoscopic (RP) nephrectomy and second group was control group and consisted from 167 patients who underwent open nephrectomy for various etiology kidney diseases.

Basic characteristics of patients are shown in table 1.

Patients had different pathologies, which were indications for nephrectomy. Indications for nephrectomy in both groups are summarized in table 2.

We used the standard technique for the RP procedure.

RPN. In contrast to the transperitoneal approach, 3 reusable, valved metal trocars were predominantly utilized (2-10 mm, 1–5 mm). Balloon dissection technique according to Gaur was accomplished to create retroperitoneal access. We used standard instruments for dissection. Titanium clips and Hem-o-lok clips were used on demand to clip the ureter, renal artery and vein.

Patient Preparation: All patients received similar perioperative treatment which included preoperative bowel preparation, cross-matching of blood, peri-operative antibiotics, deep vein thrombosis prophylaxis with low-molecular heparin and elastic stockings and a signed informed consent form.

Table 1. Table of baseline characteristics of patients

Characteristic	RP nephrectomy group (n=180)	Open nephrectomy group (n=167)	p value
Mean age ± SD	42.4 ± 15.0	46.1 ± 16.3	0.029
Age groups – no of patients (%):			
< 18	7 (3.9)	8 (4.8)	
18-30	44 (24.4)	24 (14.4)	
31-40	29 (16.1)	29 (17.4)	
41-50	36 (20.0)	29 (17.4)	
51-60	43 (23.9)	45 (26.9)	
61-70	20 (11.1)	26 (15.6)	
71-80	1 (0.6)	6 (3.6)	
Sex – no of patients (%):			
Male	96 (53.3)	79 (47.3)	
Female	84 (46.7)	88 (52.7)	
Mean BMI ± SD	27.3 ± 5.7	26.7 ± 5.9	0.350
ASA score:			
1	33 (18.3)	27 (16.2)	
2	51 (19.4)	35 (21.0)	
3	92 (51.1)	85 (50.9)	
3E	3 (1.7)	6 (3.6)	
4	1 (2.8)	5 (3.0)	
4E	0	9 (5.4)	
Side – no of patients (%):			
Left	83 (46.1)	83 (49.7)	
Right	97 (95.9)	84 (50.3)	

SD – standard deviation; RP – retroperitoneoscopic; BMI – body mass index.

Table 2. Indications for nephrectomy in both groups

Indication	RP nephrectomy group (n=180) No of patients (%)	Open nephrectomy group (n=167) No of patients (%)
1. Scarred (nonfunctioning) kidney	145 (80.55)	110 (65.87)
2. Pyonephrosis, abscess	28 (15.55)	45 (26.94)
3. Infected cysts in ADPKD	3 (1.66)	4 (2.4)
4. Unstoppable bleeding.	1 (0.55)	3 (1.8)
5. Renal trauma.	0	2 (1.2)
6. Tuberculosis.	2 (1.11)	1 (0.6)
7. Partially scarred kidney with multiple stones and recurrent urinary infections	1 (0.55)	1 (0.6)
8. Transplant rejection	0	1 (0.6)

RP – retroperitoneoscopic; ADPKD – autosomal dominant polycystic kidney disease.

Patient Positioning: Patients positioned in lumbotomy position and employed the standard technique described by Rassweiler [5,6]. After balloon dissection of the retroperitoneal space we applied three trocars and the Gerota's fascia was incised widely and the ureter explored. The dissection of the renal pedicle was routinely performed dorsally and renal vessels were clipped separately and transsected.

For the open removal of the kidneys, the technique of the supracostal lumbotomy above the 11th or 12th rib was used [1]. After incision of the Gerota's fascia, the kidney and ureter were isolated. The pedicle was dissected dorsally with transection and ligation of the renal vein and artery.

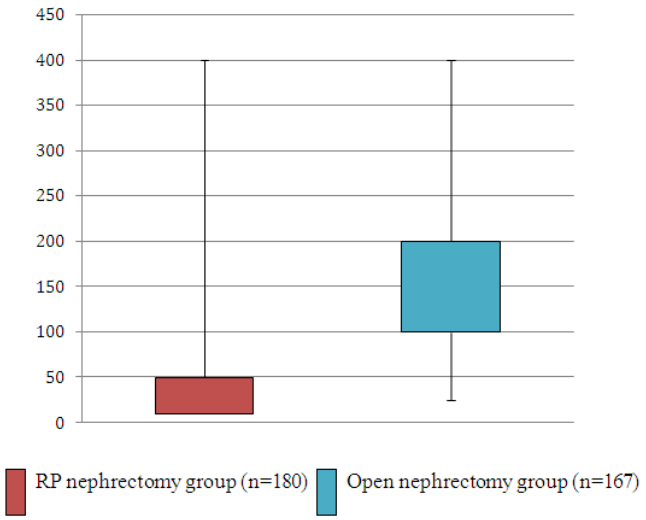
At the end of both procedures a drain was left in retroperitoneal space.

In both groups, we analyzed the parameters of clinical outcome such as total blood loss, incision length, duration of surgical procedure, doses of nonsteroidal anti-inflammatory drugs used after surgery for pain relief and postoperative hospital stay. We also assessed postoperative complications. Postoperative complications have been classified according to modified classification of Clavien-Dindo [7].

All relevant data were statistically analyzed. For normality testing we used Kolmogorov-Smirnov test and Shapiro-Wilk test. Student's t-test and Mann-Whitney U Test for continuous variables and Chi-Square tests for categorical variables were used to examine mean and proportional differences. p value < 0.05 was considered statistically significant.

3. Results

The median amount of estimated blood loss was 10 (10-400, IQR-40) mL for RP nephrectomy group and 100 (25-400; IQR-100) mL for ON group, which reliably shows that RP nephrectomy is accompanied by less blood loss ($p < 0.001$).

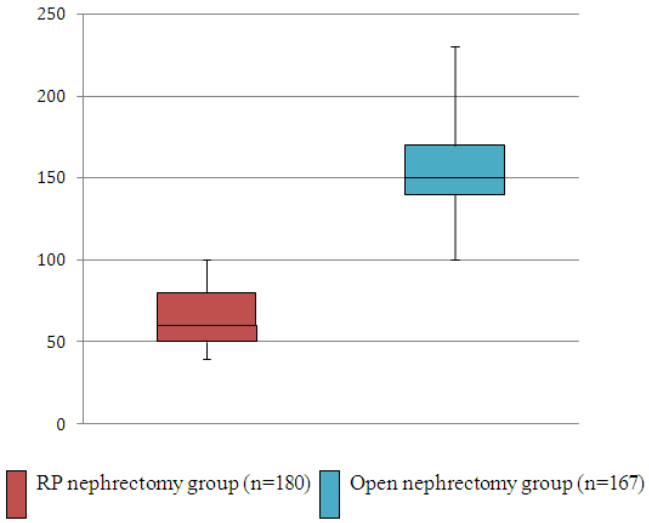


Data summary							
Groups	**Min**	**Q1**	**Median**	**Q3**	**Max**	**Mean**	**SD**
RPN group	10	10	10	50	400	37.46	49.79
ON group	25	100	100	200	400	152.26	96.33

Figure 1. Box plot chart for comparison of intraoperative blood loss in both groups in mL ($p < 0.001$). Note: outliers in this graph are not shown

3 (1.66%) patients in RP nephrectomy group had intraoperative blood loss more than 500mL, which didn't required blood transfusion. In contrast, in open nephrectomy group 12 (7.18%) patients had blood loss more than 500 mL and 10 of them required blood transfusion.

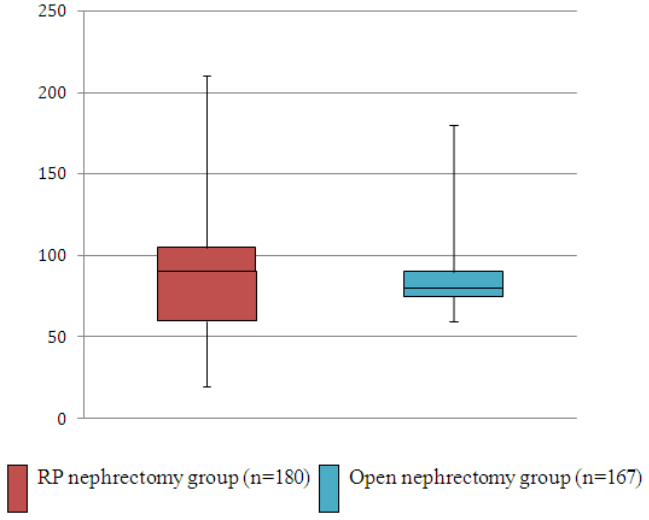
The median incision length in RP nephrectomy was 60 mm (40-100 mm; IQR – 30) - in the iliac region, and in open nephrectomy, - thoracolumbotomy, 150 mm (100–230 mm: IQR – 30), which reliably proves that RP nephrectomy cause less trauma to patient and has a better cosmetic results ($p < 0.001$) than open nephrectomy.



Data summary							
Groups	**Min**	**Q1**	**Median**	**Q3**	**Max**	**Mean**	**SD**
RPN group	40	50	60	80	100	63.67	13.32
ON group	100	140	150	170	230	154.79	17.03

Figure 2. Box plot chart for comparison of incision length in both groups in mm ($p < 0.001$)

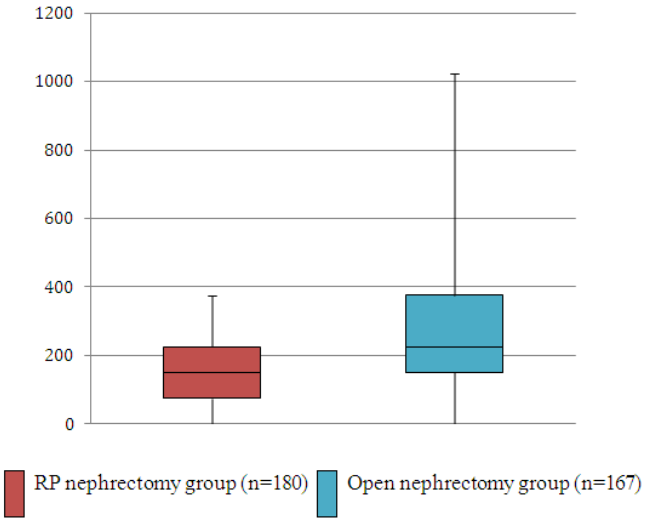
The median operative time was 90 min (20-210 min; IQR - 45) for RPN and 80 min (60-180 min; IQR - 15) for ON (Fig. 3). The operative time mainly depended in two groups on the individual intra-operative situation, such as size of the kidney or degree of perinephric adhesions. Results of statistical analysis show that operative time is not significantly different in both groups ($p = 0.711$).



Data summary							
Groups	**Min**	**Q1**	**Median**	**Q3**	**Max**	**Mean**	**SD**
RPN group	20	60	90	105	210	88.5	39.06
ON group	60	75	80	90	180	86.88	19.81

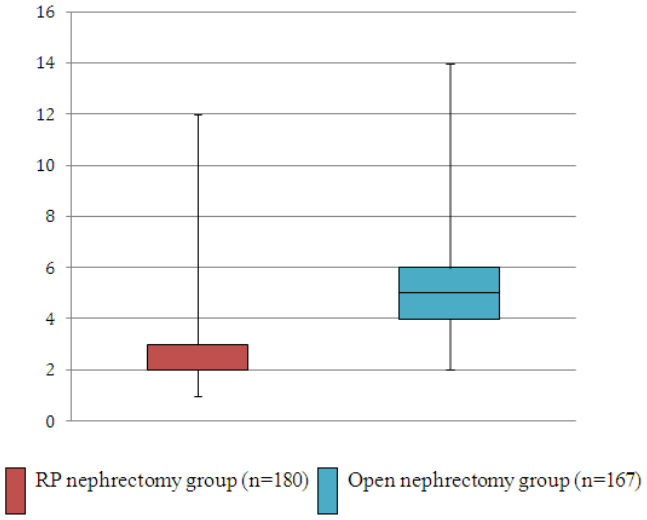
Figure 3. Box plot chart for comparison of operative time in both groups in min ($p = 0.711$)

Doses of nonsteroidal anti-inflammatory drugs (diclofenac) used after surgery for pain management were significantly different in both groups ($p < 0.001$): in RP nephrectomy group median doses of diclofenac used postoperatively was 150 mg (0-375 mg; IQR-150); in open nephrectomy group – 225 mg (0–1025 mg; IQR-225) for a hole hospital stay period.



Data summary							
Groups	**Min**	**Q1**	**Median**	**Q3**	**Max**	**Mean**	**SD**
RPN group	0	75	150	225	375	149.58	81.17
ON group	0	150	225	375	1025	290.21	203.50

Figure 4. Box plot chart for comparison of diclofenac doses for postoperative pain relief in both groups in mg ($p < 0.001$)



Data summary							
Groups	**Min**	**Q1**	**Median**	**Q3**	**Max**	**Mean**	**SD**
RPN group	1	2	2	3	12	2.52	1.26
ON group	2	4	5	6	14	5.49	2.49

Figure 5. Box plot chart for comparison of postoperative hospital stay time in both groups in days ($p < 0.001$)

The median postoperative hospital stay was 2 days (1-12 days; IQR-1) in RP nephrectomy group, in contrast 5 days (2–14 days; IQR-2) in open nephrectomy group, which is significantly higher in ON group ($p < 0.001$).

Complications.

In ON group in 33 (**19,76%**) patients we observed postoperative complications. Among them 15 (8.98%) patients developed incision site infection, in 5 (2.99%) patients there was bleeding from retroperitoneal drainage, which required to increase in draining time. Postoperatively 5 (2.99%) patients had bowel dysfunction, in 1 (0.6%) patient developed hospital acquired pneumonia, in 2 (1.2%) patients - myocardial infarction and acute cerebrovascular accident, in 3 (1.8%) patients – sepsis, in 1 (0.6%) patient – intestinal fistula. 1 (0.6%) patient died due to sepsis syndrome and multiorganal failure.

Table 3. Frequency of postoperative complications in both groups

Complication	RP nephrectomy group (n=180)	Open nephrectomy group (n=167)
1. Incision site infection	7 (3.9%)	15 (8.98%)
2. Bleeding from retroperitoneal drainage	2 (1.11%)	5 (2.99%)
3. Bowel dysfunction	6 (3.33%)	5 (2.99%)
4. Mild brachial plexopathy	1 (0.55%)	0
5. Hospital acquired pneumonia	0	1 (0.6%)
6. Myocardial infarction and acute cerebrovascular accident	0	2 (1.2%)
7. Intestinal fistula	0	1 (0.6%)
8. Sepsis	0	3 (1.8%)
9. Death	0	1 (0.6%)

Table 4. Frequency of classified of postoperative complications according to classification of Clavien-Dindo

Grade of complications	RP nephrectomy group (n=180)	Open nephrectomy group (n=167)
I	16 (8.89%)	25 (14.97%)
II	0	0
III	0	2 (1.2%)
IIIa	0	1 (0.6%)
IIIb	0	1 (0.6%)
IV	0	5 (2.99%)
IVa	0	2 (1.2%)
IVb	0	3 (1.8%)
V	0	1 (0.6%)

In RPN group in 16 **(8.89%)** we observed postoperative complications. Among them 7 (3.9%) patients developed incision site infection, in 2 (1.11%) patients there was bleeding from drainage, in 6 (3.33%) patients had bowel dysfunction. 1 (0.55%) patient developed mild brachial plexopathy, which treated by the administration of analgesia and muscle relaxers.

The complications are summarized in table 3 and classified according to modified classification of Clavien-Dindo scale [7] in Table 4.

4. Discussion

Minimally invasive methods of simple or radical nephrectomy (laparoscopic, retroperitoneoscopic) are replacing the conventional open nephrectomy. The revealed benefits of retroperitoneoscopic approach are patient comfort, improved cosmetic result and shorter convalescence [8].

As originally described by Clayman et al. [3], the technique of laparoscopic nephrectomy included several steps: re-positioning of the patient from the supine to the lateral decubitus position after obtaining a pneumoperitoneum. Furthermore, dissection of the colon, which is performed in order to gain access to the retroperitoneum, could be the risky of injury to the liver or spleen. These disadvantages supported the search for standardizing a retroperitoneal approach which – as being similar to the open access [1] – could hopefully overcome these problems.

In 1992, Gaur [4] introduced his revolutionized technique based on the insufflation of a special balloon catheter which allowed properly dissect the retroperitoneum and he has reported his experience with the first retroperitoneal laparoscopic nephrectomy [12]. In 1994, Rassweiler JJ et al. described their similar balloon dissection technique based on a hydraulic mechanism [13,14].

There are some absolute contraindications for the transperitoneal laparoscopic approach, like a history of or active peritonitis, markedly distended bowel, extensive adhesions from prior surgery, uncorrected coagulopathy and hypovolemic shock [13,15,16]. However, in the case of retroperitoneal procedures, previous open abdominal surgery or history of peritonitis are not necessarily regarded as contraindications. But, severe perinephric adhesions due to previous lumbotomies, paranephritis, xanthogranulomatous pyelonephritis, renal tuberculosis, post-traumatic renal atrophy or post-embolization nephrectomies may make retroperitoneoscopic approach mostly impossible [14].

It has noted that even among healthy patients for the open donor nephrectomy a 3.5% major complication rate and up to 30% minor complication rate were described. The operative time, although brief (90–140 min), is followed by a long hospital stay of 6.4–10.5 days [17,18]. Blohme et al. [19] have reported their series of 490 living open donor nephrectomies with a major complication rate of 1.4% and a minor complication rate of 13.6%.

Often the major criticism towards laparoscopic approach has focused on the complications that were supposed to be more frequent than in open nephrectomy. Kavoussi et al. [16] classified the possible complications into needle and trocar injuries, insufflation, dissection and closure injuries, and Gill et al. [15] presented the USA experience and complications

rate for laparoscopic nephrectomy. Vascular injuries were the most common lesions and occurred during dissection of the renal hilum or accessory vessels. Complications according to insufflation can lead to cardiopulmonary problems, hypercarbia with associated acidosis and eventually pulmonary gas embolism. Postoperative incisional hernias have been described in trocar sites larger than 10 mm [20,21].

The complications of surgery can be uniformly compared according to the modified classification described Clavien-Dindo [7] (Table 2). We also have found similar overall complication rates for each group (Table 3). It is also notable that the majority of complications in both groups was minor and was similar with other series of open or RPN [15-19,22,23].

5. Conclusions

Currently in the last 10 years, there have been performed more than 1200 cases of retroperitoneoscopic nephrectomies. Based on the results of our study we conclude that RPN should be currently recognized as the method of choice for most kidney diseases requiring nephrectomy. The main "disadvantage" in terms of operation time can be widely compensated by the advantages of less analgesia, reduced hospital stay and cosmetic advantages. The cosmetic appearance and shorter convalescence after such procedures is more attractive to the patient who is quite satisfied with the overall result.

In our experience the durability of operating time mainly depended on learning curve, the individual pathology, i.e. size of the kidney, number of renal arteries, and peri-renal adhesions.

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