

Original article

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## Laparoscopic Nephrectomy and Basic Technical Conditions Thirty Years After Launch: Our Experiences

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Laparoscopic nephrectomy is a major surgery requiring specialised training and technology. It has become a standard treatment in modern urological practice. This study analysed laparoscopic nephrectomy urological practice in our country over the past decade. Two hundred forty-eight retroperitoneal, two hundred eighty-nine transperitoneal and fifty-four laparoscopic nephrectomy procedures were performed over the ten years period at the Urology Clinic of University Clinical Center Nis. The participation of each procedure type, indications and complications were retrospectively analysed. Operative time was compared between the procedures as well as postoperative hospital stay. There was no increased volume of laparoscopic nephrectomies in the total number of surgeries during the investigated period ( $p > 0.05$ ). The operating time of laparoscopic nephrectomy was significantly longer than open surgery ( $179 \pm 24$  minutes,  $p < 0.001$ ) and hospital stay was shorter ( $4.7 \pm 1.2$  days,  $p < 0.001$ ). Complications were not significantly different in laparoscopic nephrectomy compared to open procedures, nor Grade 1-2 nor Grade 3-5 according to the Clavien Dindo classification system.

Laparoscopic nephrectomy did not become a prevalent treatment in any one of the indications during the investigated period. Laparoscopic nephrectomy has become a part of the treatment armamentarium of some urology specialists in our country. However, it is not yet a standard treatment. It is safe, efficient and less invasive than open surgery. Nevertheless, many recognised problems remain, and additional efforts are necessary to become a standard treatment modality in our country.

**Keywords:** Laparoscopic nephrectomy, open nephrectomy, minimally invasive

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**Laproskopska nefrektomija i bazični tehnički uslovi trideset godina nakon uvođenja u urološku praksu: naša iskustva**

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Laproskopska nefrektomija je velika operacija koja zahteva specijalizovane veštine i tehnološku potporu. U modernoj urološkoj praksi predstavlja dobro definisani standard. Ova studija analizira laproskopsku nefrektomiju u praksi naše zemlje u toku desetogodišnjeg perioda. Dvesta četrdest osam retroperitonealnih, dvesta osamdeset devet transperitonealnih i pedeset i četiri laproskopske nefrektomije izvedene su na Urološkoj klinici Univerzitetskog Kliničkog centra u Nišu u desetogodišnjem periodu. Učestalost svake pojedinačne operacije, indikacije i komplikacije su retrospektivno analizirane. Vremensko trajanje operacije i postoperativni hospitalni boravak analizirani su i komparirani među grupama. Nije bilo porasta frekvence laproskopskih nefrektomija u ukupnom broju operacija u toku

analiziranog perioda ( $p > 0.05$ ). Operativno vreme laparoskopskih nefrektomija bilo je značajno duže od otvorenih operacija ( $179 \pm 24$  minutes,  $p < 0.001$ ) ali je postoperativna hospitalizacija bila značajno kraća ( $4.7 \pm 1.2$  days,  $p < 0.001$ ). Nije postojala značajna razlika u komplikacijama laparoskopske nefrektomije i otvorenih operacija po gradaciji Clavien Dindo klasifikacije 1-2 niti 3-5. Laparoskopska nefrektomija nije postala prevalentni tretman niti u jednoj od analiziranih indikacija u toku perioda istraživanja. Laparoskopska nefrektomija je postala deo hirurških veština određenog broja urologa u našoj zemlji. Međutim još uvek ne predstavlja standardni podrazumevani tretman. Smatra se bezbednom, efikasnom i manje invazivnom u odnosu na otvorenu hirurgiju. Mnoge prepoznate probleme je potrebno prevazići da bi laparoskopska nefrektomija postala standardni tretman u našoj zemlji.

**Ključne reči:** laparoskopska nefrektomija, otvorena nefrektomija, minimalno invazivna

## Introduction

Laparoscopic nephrectomy (L.N.) was introduced in urology by Clayman in 1991 as an alternative to open surgery (1). Although its adoption was not as rapid as anticipated, by 2003 16% of total nephrectomies were performed laparoscopically (2). This became standard minimally invasive surgery in the Western world for patients with stage 2 renal cell carcinoma and unresectable pT1 kidney lesions (3).

Although laparoscopic procedures are fundamentally based on open surgery, they present several key differences. These include a significant reliance on technology and the requirement for specialised surgical training, which distinguishes them from traditional open surgery. The lack of standardised educational support and technology is more pronounced in developing countries. The study aims to compare laparoscopic and conventional nephrectomy to determine whether laparoscopic nephrectomy has become a viable alternative to open nephrectomy in the technical and educational constraints of our regions.

## Material and Methods

A retrospective analysis of a ten-year period database from the Clinic of Urology University Clinical Center Nis, was conducted to compare indications, procedure type, duration of the operation, complications and hospital stay of laparoscopic nephrectomy patients compared to retroperitoneal and trans-abdominal nephrectomies.

For a ten-year period, 591 nephrectomies were performed at the University Clinical Center Nis, Serbia. The procedures included 248 retroperitoneal, 289 transabdominal and 54 laparoscopic nephrectomies. Retroperitoneal and laparoscopic nephrectomies were performed in a standard manner.

### Laparoscopic nephrectomy technique

Laparoscopic nephrectomies were always transperitoneal via three or four ports: a camera port of 10mm, one or two ports of 5mm and a port of 12mm. Standard bowel preparation was performed 24 hours prior to surgery. After medial colonic displacement using a J hook or sharp dissection, the ureter was dissected and elevated to reach the lower pole of the kidney. Renal pedicle vessels were then circumferentially cleaned and clamped separately with haem-o-lock clips (artery and vein). Two haem-o-lock clips were left on the stay side and two on the kidney side in both renal artery and vein. In three cases, a 45mm laparoscopic stapler (ECHELON FLEX™ ENDOPATH, Johnson Johnson, USA) was used. In all patients with stapler ligation, both renal artery and vein were simultaneously clamped. The posterior surface of the kidney and the upper pole were then dissected using monopolar (hook) or standard bipolar cautery. Finally, the kidney was removed using the specimen retrieval pouch (Endo Catch™ Gold Specimen Retrieval Pouch, Covidien, USA).

A mini-laparotomy incision was created via an extended 12mm muscle dissecting long port incision for the extraction of the kidney specimen. The total length of the mini-laparotomy was 6-8cm. A drain was placed through the 5mm port.

Age-specific data of the operated patients was compared between the three groups. The operative procedure time measured in minutes was standardised and compared. Analgesics were administered for the first 24 hours in all groups as standard. The need for analgesics for the remainder of the hospitalisation was recorded and compared. Haemoglobin blood levels were compared to analyse blood

loss between retroperitoneal, trans-peritoneal and laparoscopic nephrectomies. The duration of necessary drainage was compared between the groups. Hospital stay was also compared in all patients. The definite pathological findings were analysed and compared to determine the final oncological outcome of the procedures. The severity of complications was evaluated according to the Clavien Dindo scale: Grade 1: any deviation of the normal postoperative course without the need for additional treatment; Grade 2: Pharmacological treatment required different from grade 1 complication; Grade 3: surgical endoscopic or radiological intervention required; Grade 4: life threatening complication with the treatment in intensive care required; Grade 5: death (4).

The results are expressed as mean  $\pm$  standard deviation. Statistical differences between groups were evaluated using one-way ANOVA and Kruskal–Wallis test for continuous variables, Mann–Whitney U test for pairwise comparisons, and the Chi-square test for categorical variables. Data analysis was performed by SPSS 16 USA statistical package. Statistical differences of  $p < 0.05$  were considered significant.

## Results

Total numbers of each type of nephrectomies are presented in Table 1. There was no statistically significant difference in the frequency of surgeries between the study years ( $p > 0.05$ ).

Table 1. Descriptive and perioperative data

Parameter	Laparoscopic nephrectomy (n=54)	Transabdominal nephrectomy (n=289)	Retorperitoneal nephrectomy (n=248)	Open* versus Laparoscopic nephrectomy (p <sup>**</sup> )
Age (years)	61.4±13.6	62.7±10.7	63.3±12.5	>0.05
Surgery time (min)	179±24	154±41	158±44	<0.001
Analgesics (days)	2.2±0.8	2.7±0.7	3.6±0.9	<0.05
Hemoglobin drop (g/L)	15.6±4.2	13.8±5.6	19±8.6	>0.05
Drainage (days)	2.7±0.8	4.1±3.5	4.8±3.2	<0.001
Hospital stay (days)	4.7±1.2	8.7±1.3	9.2±1.5	<0.001

\* transabdominal+retroperitoneal nephrectomies, total

\*\* Mann-Whitney U test

Differences in the primary data regarding surgery are summarised in Table 1. The most notable difference is that operating time is favourable for open surgery, but shorter drainage time and hospital stay are favourable for laparoscopic nephrectomy ( $p < 0.05$ ). There is a tendency to shorten operative time compared to open surgery which remains stable throughout the investigation. When the histological findings were evaluated, laparoscopic nephrectomy was used in small RCC (T1) unsuitable for nephron-sparing surgery or hydronephrotic kidneys (Table 2). Most transition cell carcinomas (TCC) were operated mainly by retroperitoneal nephrectomy (regardless of whether these cases are relatively easy to perform and convenient for L.N.). Kidneys with profound inflammatory changes are especially avoided for laparoscopic nephrectomy.

Table 2. Definitive pathological findings after surgery.

Pathology	Transabdominal nephrectomy	Retroperitoneal nephrectomy	Laparoscopic nephrectomy
RCC	253 (87.5%)	28 (11.2%)	18(33.3%)
TCC	17 (5.8%)	48(19.3%)	10(18.5%)
Inflammatory	12 (4.1%)	95(38,3%)	4 (7.4%)
Miscellaneous*	7(2.5%)	77(31.1%)	22(48.1%)
Total	289 (100%)	248(100%)	54(100%)

\* Hypotrophy, hydronephrotic, nonfunctioning kidneys

The distribution by severity of complications evaluated according to the Clavien Dindo scale (4) is shown in Table 3. The total number of complications was not different compared to open surgery (13/54;24.1%;  $p > 0.05$ ). The worst complications (lethal) occurred twice in the laparoscopic nephrectomy series due to inflammatory complications (sepsis) several days after successfully completing the operation. Conversion to open surgery was performed in 8/54 (14.8%) cases due to intestinal fistula/injury or bleeding. Serious complications which required redo surgery, intensive care unit admission, and death (Clavien Dindo grade 3-5) were not statistically significant between the groups ( $p > 0.05$ ). There were five bowel perforations and three cases with severe bleeding which required open surgery.

Table 3. Complications of the surgery classified according to the Clavien Dindo scale (4).

Clavien Dindo*	Transabdominal nephrectomy (N=289)	Retroperitoneal Nephrectomy (N=253)	Laparoscopic Nephrectomy (N=54)
Grade 1	15	17	2
Grade 2	31	42	3
Grade 3	12	7	4
Grade 4	3	5	2
Grade 5	5	4	2
Total	66/289 (22.8%)	75/253 (29.6%)	13/54(24.1%)

\*Grade 1: any deviation of the normal postoperative course without the need for additional treatment; Grade 2: Pharmacological treatment required different from grade 1 complication; Grade 3: surgical endoscopic or radiological intervention required; Grade 4: ife threatening complication with the treatment in intensive care required; Grade5: death (4). Grades 3-5 represents sirious complications.

There were no cases with local recurrence or readmission during the follow-up.

## Discussion

Our results confirmed that both laparoscopic nephrectomy and open nephrectomies (transabdominal and retroperitoneal) could be considered as safe and efficient procedures with a complication rate comparable to the literature (5). However, there was no significant increase in laparoscopic nephrectomies during the past decade despite strong EAU guidelines recommending its use whenever possible for TCC and RCC (3).

Although the low diffusion rate of laparoscopic nephrectomy is a recognised phenomenon elsewhere (6,7), in our circumstances the number of laparoscopic nephrectomies performed remained constant at approximately 10% of the total number of cases annually. This contrasts with laparoscopic surgery such as cholecystectomy which has transformed general surgical practice.

Even though laparoscopic nephrectomy in our investigation was predominantly performed by one surgeon (87% of 54 cases), the total number of surgeries remained below 10 annually, which is the threshold required to become a standard treatment after six to nine years (7). Several factors contribute to this common acceptance: laparoscopic nephrectomy is more demanding and more complex surgery compared to laparoscopic cholecystectomy; the learning curve is steep; nonstandardised training programmes are in place; non-obligatory laparoscopy skills are required during residency; there is a shortage of learning staff; and the non-competitive health system lacks the initiative to prioritise the most prominent type of surgery for patients.

Educational challenges are often the most difficult to overcome. The training programme for urological laparoscopy is not well standardised. The conversion rate (6/54-11.1%) is higher than previously reported (5). Four out of six conversions occurred in the first twenty cases. The standard progression of laparoscopic urology in a developing country (and in our centre) was based on a four-hour laparoscopy course and several days of training with one or two animal operations. Live surgery commenced with general surgeons experienced in gallbladder surgery and progressed to basic urological skills (varicocele and renal cyst resection). The lack of highly qualified mentors led to numerous initial mistakes which

were fortunately repeated without fatal consequences. Although there is no consensus regarding the optimal tailoring of urological laparoscopy training, individual self-education is undoubtedly the most deficient. It is widely accepted that simulation in urology training is highly beneficial in addition to the individual training schedule (8,9,10). It is generally agreed that between 17 and 32 mentored nephrectomy cases are necessary for independent practice (8).

The oncological outcome is the primary concern for patients with neoplastic disease. However, issues regarding the efficacy of open and laparoscopic nephrectomy have been resolved for some time and even pT2 neoplasms are considered suitable for laparoscopic nephrectomy (11,12,13). Consequently, although robotic surgery has significantly evolved, laparoscopic nephrectomy remains a cornerstone of urological training (14).

There was a notable difference in operating time. Laparoscopically operated patients had significantly shorter hospital stays and drainage times. Laparotomy size (6-8 cm) was also considerably smaller after laparoscopic surgery.

Complications in laparoscopic nephrectomy were comparable to the complication rate in other reports (15,16,17,18). However, whether surgery is considered less invasive, complications are not less severe. Furthermore, there is an interesting observation that if a complication occurs in laparoscopic nephrectomy patients there is a higher probability of a fatal outcome (16).

The most frequently reported severe complications in our series and others were bowel perforations and bleeding (19, 20). Laparoscopic nephrectomy was not performed in our series in cases with previous abdominal surgery or severe inflammatory kidney disease. Neither one is now considered a contraindication for laparoscopy (20).

In three cases bowel perforations were identified; one was recognised during surgery and the other two several days later because of a prolonged febrile state. A stercoral fistula was subsequently recognised. The active approach was unnecessary in one case because the fistula was self-limiting and spontaneously healed. In two instances a proximal colostomy was performed. Gastrointestinal injuries are not usually recognised during surgery (16). However, they have recently been recognised in most cases necessitating subsequent surgery (18). In laparoscopy energy resources, typically the most responsible cause of bowel injury, include monopolar, standard bipolar current and ENSEAL™ (Ethicon

Endo-surgery, US, LLC). However, only bipolar and monopolar surgery were available and both were cautiously used. It is important to note that all energy resources have a lateral thermal energy effect and cause inadvertent tissue damage (21). Awareness of the “accidental punctures and lacerations” phenomenon is also necessary to improve surgical safety (22). Therefore, commonly used devices with minimal energy dispersion are recommended (21). In the circumstances described, with minimal technical equipment, a J hook and monopolar current were used away from the intestine and on the posterior side of the kidney. Limited use of the J-hook was performed in the upper pole of the kidney. Sharp dissection close to the intestinal wall was used (23). Laparoscopic suture, although more complex, was performed in problematic cases instead of thermal energy but a fistula still occurred.

The second issue, dissection of the hilum and haemostasis during left nephrectomy, is of the highest importance. Although a developed technique of laparoscopic knot tying is available it is uncommon (24). Furthermore energy-using devices (monopolar, bipolar, etc.) are used only for minor vessels not the renal hilum. Stapling devices, polymer clips (Hem-o-lock) and standard titanium clips are routinely used for hemostasis as well as in our experience.

Staplers were introduced in laparoscopy with the expectation that three transfixion suture lines placed on each side of the cutting line would prevent dislodgement and provide sufficient haemostasis even in cases with elevated blood pressure. However, the instrument is bulky and relatively difficult to manipulate, particularly with short renal vessels on the right side. In our experience, it was successfully used three times in cases with difficult skeletonization of renal vessels. The efficacy of staplers is variable and a clear advantage over other methods has not been documented (25). The significant cost of approximately 400 US dollars is a major barrier to their adoption in developing countries. Haemostatic performance was not superior to polymer (hem-o-lock) clips (25). A block stapled ligation of the renal hilum appears safe without the increased risk of renal fistula (26,27).

Conventional titanium clips are not considered safe for the renal artery but can be placed without precise skeletonization (27). In our experience, they were used for temporary occlusion to minimise tearing (droplets of bleeding) from the kidney. Additional hem-o-lock clips were also placed on the stay side, at least 2 of them. New design titanium clips (DS-titanium ligation clip (AESCULAP<sup>a</sup>)) are promising as they retain the advantages of titanium and hem-o-lock clips (28).

Polymer clips (hem-o-lock) are used for haemostasis in the renal artery and on the renal vein, excluding cases where the haemostatic stapler is used. Additional tissue surrounding the vessel is avoided to prevent the late opening of the forcefully closed clips (29).

Sepsis is a significant cause of death primarily due to its non-surgical origin. Several reports suggest that adequate overall support including staff education technology and full compliance with the Surviving Sepsis campaign could improve outcomes and reduce mortality. However, while intensive care unit support was provided, full adherence to the criteria approach was not consistently observed (30).

The strength of the study is that it is a single-centre experience. Surgery was performed by a limited number of surgeons with one who conducted the majority of operations. The study's limitations include its retrospective nature and the varying sample sizes. Furthermore, open surgeries were performed without the careful selection of the surgeon.

### **Conclusion**

Laparoscopic nephrectomy has become a therapy approach performed by some urology specialists in Serbia. However, it is not yet a standard treatment. However, it is not yet a standard treatment. It is safe, efficient and less invasive than open surgery. The associated issues are its limited use, the number of surgeons performing it and the extensive training required to become a standard treatment modality.

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