

## NEPHRON SPARING LESS: TECHNIQUE AND REVIEW OF THE CURRENT LITERATURE

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**Summary.-** OBJECTIVES: Background. Nephron-sparing surgery (NSS) ensures excellent oncological and functional outcomes in treating small renal masses. Laparo-Endoscopic-Single-Site Surgery (LESS) is one of the major advances in the evolution of minimally invasive surgery.

METHODS: A prospective evaluation of patients underwent LESS NSS at our institutions for a solitary, exophytic, enhancing, small ( $\leq 4.0$  cm) renal masses and normal contralateral kidney was done. Peri-operative, pathological, hematological data together with a subjective evaluation of the pain (VAS) and the scars were collected. A comprehensive electronic literature search

was conducted in May 2011 using the Medline database to identify all publications relating to LESS NSS.

RESULTS: Fourteen patients were operated by a LESS unclamp NSS and 6 patients by a clamp LESS NSS (mean operative time: 125min and 137.4 min; mean blood loss: 207 ml and 113 ml). The mean warm ischemia time in the LESS clamped NSS was  $11.1 \pm 2.4$  min using an early unclamped technique. Neither conversion to open surgery nor transfusions occurred. Three patients required conversion to standard laparoscopy. Postoperatively, we recorded 1 Clavien II (acute gastritis), 1 Clavien IIIa (urinary fistula after NSS) and 1 Clavien IV (cerebral stroke) complications. Pathology revealed 13 T1a clear cell carcinoma, 4 complex renal cysts, 2 oncocytoma and 1 angiomyolipoma (surgical margin positive). With a minimal postoperative pain (VAP: 1.8 in POD1) the patients were discharged after 4.4days without variation in eGFR. No local or distant progression was detected. Current literature suggest that LESS NSS can safely and effectively be performed in a variety of urologic settings and represent one of the major interests among the LESS procedures. Although, the quality of evidence of all available studies remains low, mostly being small case series or case control studies from selected centers.

CONCLUSIONS: LESS NSS in selected renal masses is feasible, provides postoperative outcomes overlapping the standard counterpart and ensures subjective satisfaction. A more extensive surgical experience and a prolonged follow-up are necessary to point out the role of this technique.

**Keywords:** Partial nephrectomy. Laparoscopy. Minimally invasive surgery. LESS. Renal cancer. Ischemia.



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**Resumen.- OBJETIVO:**

in the clinical field, being safe and feasible in the hands of experienced laparoscopic surgeons in well-selected patients (1-2). All extirpative and reconstructive urological procedures has been described. However, nephron-sparing surgery (NSS) represents one of the most complex procedures. Autorino judged these procedures as at "medium potential role in the future" because it could require an extraumbilical insertion of a multichannel trocar, a challenging suture, an increased risk of bleeding together with a prolonged warm ischemia time (1).

NSS ensured an improved renal function and life expectancy resulting from the preservation of healthy parenchyma (3). Laparoscopic (LPN) NSS combining the preservation of renal function and the minimal invasiveness of laparoscopy represents a robust alternative to open surgery especially because the incidence of benign lesions on final histopathology is high (nearly 30%) in small incidentally-discovered renal masses (4-5).

The hilum clamping is an essential but not mandatory step for both open and laparoscopic NSS, however also a short ischemia time seems to cause clinical and subclinical renal injury at long-term follow-up (6-7).

To avoid the systematic hilum clamping during NSS different authors proposed some criteria to help clinicians in selecting the patients who benefit from an unclamp technique. And more recently, Eisenberg developed and described a new technique of 'zero ischemia', unclamped LPN and robot-assisted LPN, using a pharmacologically induced hypotensive technique(8).

Our group pioneered the laparoendoscopic single site partial nephrectomy (LESS NSS) and described both the unclamp and the ischemic techniques achieving favourable intraoperative and postoperative results (8-9). Nowadays, several series of LESS NSS have been reported, so that available evidence on this surgical procedure is sufficiently large (10-16). Aim of this study is to describe our surgical technique and our results, together with an overview of the current status of LESS NSS providing an analysis of the outcomes.

**Palabras clave:** G

**INTRODUCTION**

Since its initial clinical use in urology, there has been an increasing enthusiasm and a growing interest for the laparoendoscopic single site surgery (LESS). LESS has proved to be immediately applicable

**MATERIALS AND METHODS*****Patients and surgery***

From April 2009 to May 2011, a prospective analysis of the patients who underwent laparoscopic partial nephrectomy through a single multi-channel

port in two laparoscopic high-volume centers (Vasto and Halle) was done. All relevant clinical information was introduced into a multi-institutional database. Patients were strictly selected on the basis of a single, exophytic, cortical, small renal mass ( $\leq 4.0$  cm). After a careful selection of patients with small, peripherally located renal masses and normal contralateral kidney 20 cases have been prospectively identified and enrolled.

All patients consented single port procedures accepting also additional incisions/ports or open surgery if necessary. All demographics data, comorbidities, Body Mass Indices (BMI), pre- intra- and postoperative variables were prospectively collected.

The Visual Analog Pain Scale (VAPS) (1: negligible pain – 10: severe discomfort/pain) allowed for pain assessment postoperatively (POD1). The cosmetic effect of the scar was reported at the first follow-up visit by the patients (arbitrary and subjective opinion: unsatisfied, satisfied, very satisfied, and enthusiastic). Stage and grade tumor were assigned following TNM 2010 (17). All surgical complications were classified according to the Dindo-Clavien classification (18).

### Technique of unclamp LESS-NSS

With the patient placed in the 45-60 degrees modified-flank position and the operating table minimally flexed a transperitoneal approach was preferred in all cases following the typical open "Hasson" access technique. We used a Triport™, Quadport™ trocar (Advanced Surgical Concepts, Ireland) and Endocone (Karl Storz, Tuttlingen, Germany) (Figure 1).

Using a rigid 5mm and 10mm, 30-degree-lens laparoscope, both standard and articable instruments (Covidien, Mansfield, MA) were used for dissection and tumor exposure. The excision under normal renal perfusion was done by LigaSure™ (Covidien, Mansfield, MA) 5-mm laparoscopic instrument and bipolar scissor. The surgical strategy followed the conventional laparoscopic NSS (19). After the excision of the neoplasm, the hemostasis was achieved by bipolar electrocautery, Tabotamp™ bolster (Johnson&Johnson, New Brunswick, NJ), FloSeal™ (Baxter Inc, Deerfield, IL) and separate parenchymal stitches. The tumor was extracted entrapped in an endoscopic bag and a tubular drain was left in situ.

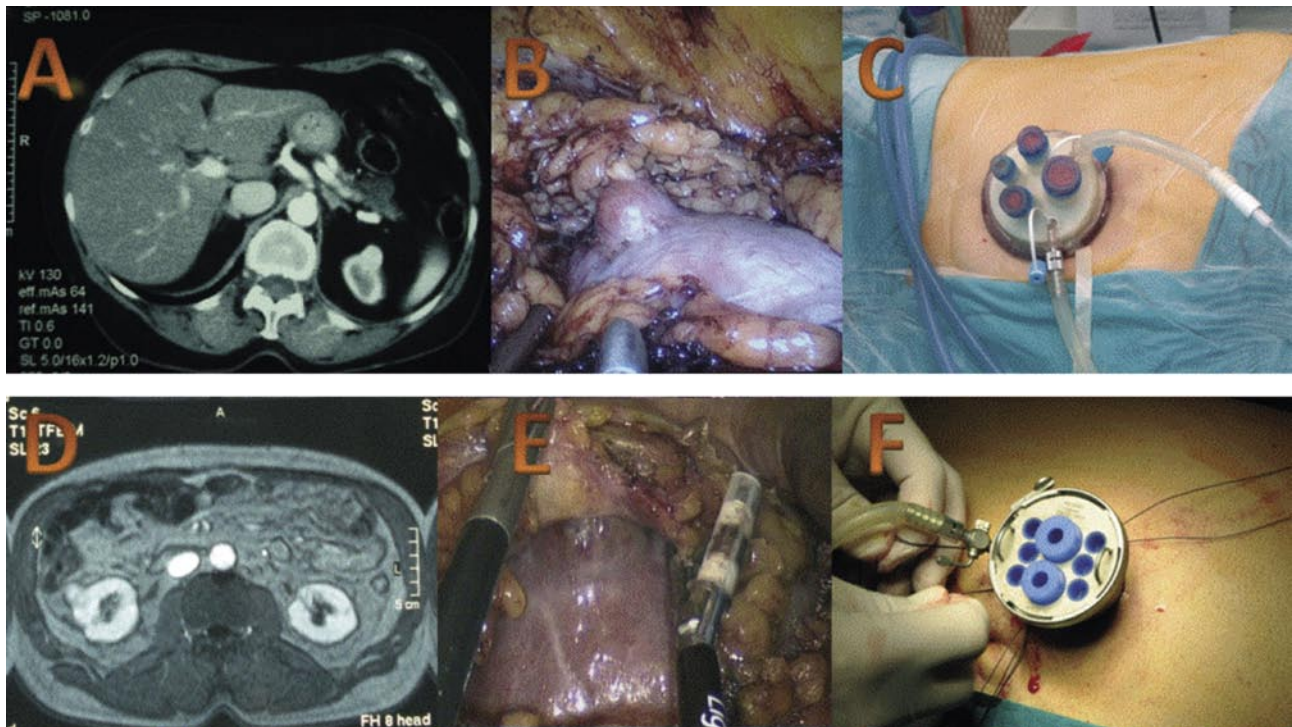


FIGURE 1. Unclamp LESS NSS: typical preoperative imaging of small renal masses (A and D), intraoperative view of the exophytic renal neoplasms after kidney surface exposure (B and E), extracorporeal view of the multichannel trocars (Quadport™ in C and Endocone™ in F).

### Technique of clamp LESS-NSS

With the patient placed in the 60 degrees modified-flank position and the operating table minimally flexed a transperitoneal and umbilical approach was preferred in all cases following the typical open "Hasson" access technique, using a SILS-port (Covidien, Mansfield, MA) or an Endocone (Karl Storz, Tuttlingen, Germany) (Figure 1).

Using a rigid 5mm and 10mm, 30-degree-lens laparoscope, both standard and bent instruments (Karl Storz, Tuttlingen, Germany) were used for dissection and tumor exposure.

After lifting the lower pole, the renal hilum is under gentle tension in order to prepare the vessels. The renal vein at the first and the renal artery are identified. The kidney is mobilized within Gerota's fascia and defatted and the tumor is localised. The renal artery is then clamped with one laparoscopic bulldog clamp (Figure 2).

The tumour is excised with cold curved shears in a near-bloodless field. Renal parenchymal repair is performed with running sutures. A PDS-Clip is secured on the suture to prevent it from pulling through. Another clip is applied to the suture flush with the opposite renal surface, compressing the kidney (Figure 2). The bulldog clamp is then removed and fibrin glue is applied to the cut renal parenchymal surface. The en bloc specimen is extracted in a 10-mm Endocath II bag.

### Bibliographic research

A comprehensive electronic literature search was conducted in May 2011 using the Medline database – through either PubMed or Ovid as a search engine – to identify all publications relating to LESS NSS. The search was conducted using a free-text protocol that included the following terms: nephron sparing surgery; partial nephrectomy, laparoendoscopic single-site surgery; single-port access surgery; single-incision laparoscopic surgery. Moreover, experience gained at authors' own institutions was considered.

## RESULTS

### Unclamped LESS-NSS series

Fourteen patients (mean age  $61 \pm 11$ y, BMI 26, 10 men) underwent an unclamp single port partial nephrectomy. We used a Triport™, Quadport™

trocar (Advanced Surgical Concepts, Ireland) and Endocone (Karl Storz, Tuttlingen, Germany) in 8, 2, and 4 cases respectively (Figure 1). With a mean operative time of  $125 \pm 39$ min and a mean estimated blood loss of  $207 \pm 214$ ml, all masses have been successfully resected (mean tumor size 2.5cm). No patients needed a conversion from an unclamp technique to an ischemic one. The haemostasis has been successfully achieved without postoperative transfusions by the sequential use of bipolar cautery, cellulose bolster, haemostatic agent and stitches (only in 4 cases).

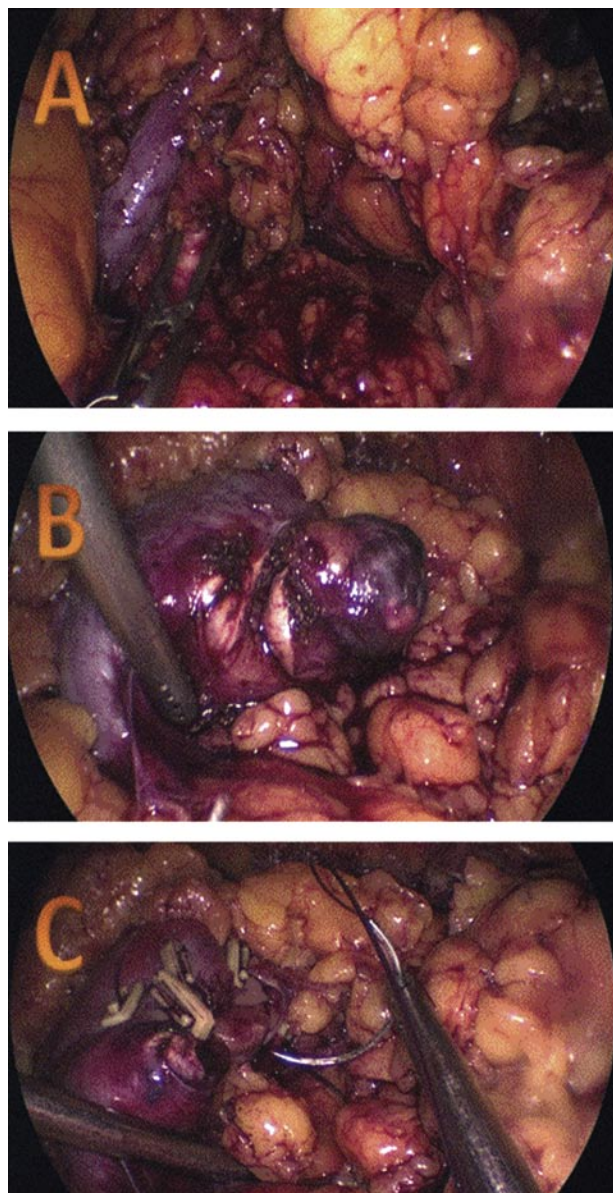


FIGURE 2. Clamp LESS NSS: intraoperative view of the typical steps of NSS. Placement of bulldog clamp (A), resection of the neoplasm (B), suture of the parenchymal defect (C).

Three patients required conversion to standard laparoscopy in order to expose a posterior mass (1 case) and to control an excessive bleeding (2 cases). Postoperatively, 1 Clavien II (acute gastritis), 1 Clavien IIIa (urinary fistula after NSS) and 1 Clavien IV (cerebral stroke) complications occurred. Pathology revealed 8 T1a clear cell carcinoma, 4 complex renal cysts, 1 oncocytoma and 1 angiomyolipoma (surgical margin positive). No variation in eGFR was seen at follow-up visit. A 2g/dl postoperative hemoglobin decrease was recorded and the IPOD pain score was 1.8/10. The patient who had a cerebrovascular accident (occurred 10 hours after surgery) developed a left hemiparesis. The patient who developed the perirenal urinoma in 17th POD was treated by a double J ureteral stent. The patient, with a history of *Helicobacter Pylori*-related chronic gastritis, who complained of acute gastritis was successfully treated by intravenous proton pump inhibitor. Mean length of stay was  $4.4 \pm 2.2$  days. All subjects confirmed a high satisfaction about the scars (9 enthusiastic/very satisfied and 5 satisfied) with a mean skin incision of  $3.5 \pm 0.5$  cm.

### **Clamped LESS-NSS series**

Six patients (mean age  $58.7 \pm 9.3$  y, BMI 27.2, 4 men and 2 women) underwent an clamped single port partial nephrectomy. We used a SILS-port (Covidien, Mansfield, MA) and an Endocone (Karl Storz, Tuttlingen, Germany) in 4 and 2 cases, respectively. With a mean operative time of  $137.4 \pm 16.4$  min and a mean estimated blood loss of  $113 \pm 32$  ml, all masses have been successfully resected (mean tumor size 3.1 cm). The mean warm ischemia time resulted in  $11.1 \pm 2.4$  minutes using an early unclamped technique. In 4 cases an additional 3 mm trocar was used and no intraoperative and postoperative complication occurred. Pathology revealed 5 T1a clear cell carcinoma, and 1 oncocytoma and negative surgical margins were reported in all patients. No variation in eGFR was seen at follow-up visit. Mean length of stay was  $4.7 \pm 1.1$  days. All subjects confirmed a high satisfaction about the scars (6 enthusiastic/very satisfied) with a mean skin incision of  $3.5 \pm 1.2$  cm.

### **Analysis of the available literature**

The PubMed search revealed 7 surgical series of LESS NSS (Desai and Aron, White, Kaouk, Rais-Bahrami, Choi and Cindolo/Schips), describing overall 104 cases also including our updated experience. No randomized or comparative clinical trial have been found. The surgical relevant data

were collected in the Table 1. Overall, renal masses  $< 3$  cm were selected for a LESS NSS that took a mean OR time ranging from 125 to 270 min. The mean EBL ranged between 100 and 475 ml. The occurrence of a severe postoperative complication ( $\geq$  III Grade Clavien) was reasonably low 6/104 (5.7%).

## **DISCUSSION**

The entire spectrum of urological procedures both for upper and lower urinary tract diseases has been described and shown to be feasible and safe, including advanced reconstructive procedures and major extirpative ones as described in the first worldwide multi-institutional database (20).

Although almost every laparoscopic procedure in urology has been duplicated by using a LESS approach, just few studies have been reported so far on problems and challenges encountered during LESS partial nephrectomy (10-16).

Laparoscopic partial nephrectomy (NSS) still represents a technically demanding procedure. In the last decade, laparoscopic NSS gained an increased popularity among the urologists and an expansion of its indications (22). Besides the standard transperitoneal or retroperitoneal laparoscopic approaches, laparoscopic partial nephrectomy has also been attempted by a LESS approach. Our increasing experience in this field has today reached 20 cases. Only patients with solitary, exophytic, peripheral, enhancing, small ( $\leq 4.0$  cm) renal masses and normal contralateral kidney are considered the best candidates for LESS-NSS.

With operative time and blood loss overlapping those of standard laparoscopy, all masses have been successfully resected. Using bipolar cautery, bolster, and haemostatic agents in most cases and stitches, a good hemostasis has been achieved. Our findings demonstrate the feasibility of LESS-NSS in highly selected renal masses and confirm the findings of the first report from Kaouk (14).

All the data concerning the LESS ischemic NSS showed that it is feasible at least in the hands of experienced laparoscopic surgeons, however the technique still in its infancy especially in comparison with the number of radical and simple nephrectomy done so far (1,20). As expected the occurrence of a severe complication ( $\geq$  III Grade Clavien) is low and we think that it could be explained considering that in a variable percentage of the cases additional trocars were used (for organ retraction, for suturing, for the control of bleeding vessels). As described by

several authors, once additional ports were placed, the operative field was quickly managed and the difficulties overcome (10,13). Especially for LESS NSS the use of additional port should not be viewed as a complication and should be undertaken liberally if the surgeon is uncomfortable during LESS or during the learning curve.

Even if the main benefits of the LESS are very clear and still to be demonstrated, some questions remain to be answered:

- **Is LESS oncologically safe?**

In our opinion, although laparoscopic procedures demonstrated several advantages over their open surgical counterparts in a couple of decades, the advantages of LESS over standard laparoscopy are likely to be proven in a much shorter period of time. The lack of sufficient demonstration of the superiority or equivalence of LESS over conventional laparoscopy could be explained by the young age of LESS. Future studies are expected, including a long-term follow-up to define the oncological safety of this technique. However, as it duplicates the laparoscopic technique, its outcomes are not likely to be poorer.

- **Does LESS represent just a surgical fad or a sea change?**

We think LESS is here to stay. Patients are going to demand LESS surgery and laparoscopic surgeons will have to embrace their demands, with full respect of all ethical and methodological issues. Although cure and safety remain the main concern ("first do not harm"), the population has a favorable perception of scarless surgery, even in the case of increased procedural risk, with LESS favored over transluminal surgery (NOTES).

Because of 1) the not negligible number of ongoing clinical trial (clinicaltrial.gov) on LESS; 2) the high quality of new papers about comparison of LESS vs standard laparoscopy (especially in general surgery), 3) the increase of demands from patients looking for an invisible surgery, 4) the possibility to perform LESS with homemade multichannel port, 5) the useful interaction between surgeons and companies in developing new devices, we consider the LESS not as a surgical useless exercise but the new frontier to be explored keeping in mind the lesson from Ulysses towards the Pillars of Hercules "to gain knowledge of the unknown". The story is not new! Millions of patients over the last decades underwent laparoscopic cholecystectomy, which forces brave

TABLE I. LESS NSS: LITERATURE OVERVIEW.

Author, year	N	Robotic	Mean tumor size (cm)	Mean operative time (min)	Mean EBL (ml)	Length of stay (days)	Mean ischemia time (min)	Transfusion rate (%)	Complication $\geq$ III Grade Clavien	Additional trocars % (diameter)
Desai and Aron 2008	6	0	3	270	475	7.2	20	0	2/6	100% (6x2mm; 1x5mm)
White 2008	15	4	3.01	196	422	4.5	na	26	0/15	13% (na)
Kaouk 2008	7	2	2.1	165	260	3.3	0 in 6 pts 16 in 1 pt	14	0/7	14% (na)
Rais-Bahrani, 2009	3	0	2.5	149	100	2	27	0	1/3	0%
Choi 2011	59	56	2.6	212	171	4.5	27.5	13	1/59	Most of the cases (12mm)
Schips 2011	14	0	2.5	125	207	4.4	0	0	2/14	50% (2x 3mm; 5x 5mm)
Greco 2011	6	0	3.1	137.4	113	4.7	11.1	0	0	66,6% (4x3mm)

but cautious surgeons to move and go “plus ultra” beyond the Herculean pillars.

• **Should LESS be regarded as matter of surgical innovation or experimental surgery?**

A recent paper published focused on the possibility to organize the surgical innovation path in a five stage model (22). The authors proposed a descriptive tool delineating stages of Innovation, Development, Exploration, Assessment, and Long-term study (the so called IDEAL model). Following this classification the LESS NSS could be classified as stage 2b. In particular, this “Exploration” phase occurs once the procedure has been described and the main technical aspects worked out.

Experience with the procedure may still be in its infancy, and outcomes with larger numbers of patients are usually needed before a randomized clinical trial (RCT). In fact the number of study with LESS NSS is increasing but a RCT that compares this new approach with open and laparoscopic NSS is still lacking.

At this stage, the procedure is likely to be adopted by more surgeons from different Institutions, making the issues of mentoring and learning-curve evaluation crucial. Data should be captured systematically for every patient having the procedure, especially to ensure that adverse outcomes are documented (23). The transition to the next stage 3, the so called “assessment”, will occur once LESS is sufficiently evolved to warrant full evaluation by means of RCTs.

## CONCLUSIONS

LESS NSS is feasible for selected renal masses, providing postoperative outcomes overlapping the standard counterpart and ensuring subjective satisfaction. A more extensive surgical experience and a prolonged follow-up are necessary to point out the role of this technique.

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