World Journal of Clinical Urology

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DOI: 10.5410/wjcu.v3.i3.358

World J Clin Urol 2014 November 24; 3(3): 358-363
ISSN 2219-2816 (online)

RETROSPECTIVE STUDY

Single-site laparoscopic partial nephrectomy: Where are we going?

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Received: April 18, 2014 Revised: June 23, 2014
Accepted: July 29, 2014
Published online: November 24, 2014

Abstract

AIM: To review an evolution of laparoscopic surgery, there has been a growing interest in laparoendoscopic single-site surgery (LESS).

METHODS: A comprehensive electronic literature search was conducted using PubMed database to identify all publications relating to LESS-partial nephrectomy (PN). The research includes articles published from April 2008 to January 2014. We focused our attention only on articles in which were cited the single-site surgical technique (laparoscopic and robotic), tumour stage and grade, mean tumour size, intraoperative variables, blood loss and transfusion rate, length of post-operative stay and complication rates, Clavien classification, positive of surgical margins, pain assessment at discharge.

RESULTS: A total of 9 studies were collected with 221 patients included. The mean patients age was 62 years. The mean tumor size was 2.35 cm with a mean operative time of 181 min (range 111-270 min) and 58.3% were done by robot. The mean ischemia time was 23.6 min. The 25.8% of patients underwent an unclamp LESS-PN. Mean estimated blood loss was 296 mL and median length of hospital stay was 4 d. The rate of severe post-operative complications (≥ Clavien grade Ⅲ) was 5.4%. Not all surgical series of LESS-PN or Robotic-LESS-PN shows conversion in Multiport Laparoscopic or Open Surgery. Regarding oncologic outcomes, surgical margins were positive 4% of patients (9/221), no distant or port-site metastases were recorded.

CONCLUSION: LESS-PN and RLESS-PN are feasible and associated with reduced postoperative pain, shorter median hospital stay, shorter recovery time, and better cosmetic satisfaction without compromising surgical and oncological safety.

Key words: Nephron sparing surgery; Partial nephrectomy; Laparoendoscopic single-site surgery; Single-port access surgery; Single-incision laparoscopic surgery; Robotic single-port partial nephrectomy

Core tip: In recent years, there has been a growing interest in laparoendoscopic single-site surgery (LESS). Some authors has used da Vinci surgical system for LESS surgery. Although almost every laparoscopic procedure in urology has been duplicated by using a LESS approach, only a few studies have reported problems and challenges encountered during LESS partial nephrectomy. The aim of our study is to evaluate the current literature in order to assess the efficiency, safety, and potential advantages of LESS-partial nephrectomy and Robotic-LESS PN.

Castellucci R, Cindolo L, Alvaréz-Maestro M, Giusti G, Be-

rardinelli F, Pellegrini F, Schips L. Single-site laparoscopic partial nephrectomy: Where are we going? *World J Clin Urol* 2014; 3(3): 358-363 Available from: URL: http://www.wjgnet.com/2219-2816/full/v3/i3/358.htm DOI: http://dx.doi.org/10.5410/wjcu.v3.i3.358

INTRODUCTION

Renal cell carcinoma represents 2%-3% of all cancers with an age-standardised rate incidence and mortality of 5.8 and 1.4 per 100000, respectively, in more developed areas[1].

The widespread use of modern imaging methods has resulted in a marked increase in the number of renal tumors detected incidentally in patients with non-urological symptoms[2]. These tumors are often of lower grade and stage, and nephron-sparing surgery (NSS) is a good treatment option for small (≤ 4 cm) renal lesions[2,3].

Currently available evidence suggests that localized kidney cancer is best managed by NSS whenever technically feasible[4].

Although open partial nephrectomy (PN) is considered the "gold standard" in the surgical therapy of T1 renal tumors, advances in laparoscopic surgery have led to increasing use of laparoscopic PN (LPN) for NSS[2].

LPN has also gained popularity, but is currently performed mainly in high-volume reference centres, and its diffusion has been limited by the steep learning curve[5].

Laparoscopic 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[2,6].

In recent years, there has been a growing interest in laparoendoscopic single-site surgery (LESS), an evolution of laparoscopic surgery. "Single-site surgery" is the term given to various laparoscopic techniques that use a single skin incision to gain access to the abdominal cavity[7]. It has been proved to be applicable in the clinical field, being safe in hands of experienced laparoscopic surgeons in well-selected patients[8,9].

LESS tries to overcome even the rare port-related complications of laparoscopy and seems to achieve a fast and painless postoperative recovery with excellent cosmetic results[10,11].

Cindolo *et al*[12,13] were pioneers in the field of LESS-PN, and described the unclamped technique in 2009, achieving favourable early outcomes. Although almost every laparoscopic procedure in urology has been duplicated by using a LESS approach, only a few studies have reported problems and challenges encountered during LESS partial nephrectomy[14,15]. In spite the development of new specific equipment for LESS, the surgical instruments have limited range of motion, and clashing of instruments is a major disadvantage[14]. For this reason, some authors have used da Vinci surgical system for LESS surgery[16,17]. The introduction of robotic technology has provided some attractive features such as magnified 3D vision, articulating instruments, scaling of movement, tremor filtration, fourth robotic arm assistance, and a live intraoperative ultra-sound platform. Consequently, these features have reduced the crowding of instruments, enabled better precision with tumor resection and renal reconstruction. Nevertheless, there is still paucity of relevant studies of Robotic LESS-PN (R-LESS-PN) on its intermediate term clinical outcomes as it is a relatively new approach[16].

The aim of our study is to evaluate the current literature in order to assess the efficiency, safety, and potential advantages of LESS-PN and R-LESS PN.

MATERIALS AND METHODS

Bibliographic research

A comprehensive electronic literature search was conducted using PubMed database to identify all publications relating to LESS-PN. The research includes articles published from April 2008 to January 2014; it 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, robotic single-port partial nephrectomy.

The inclusion criteria for LESS were single, exophytic, cortical, small (4.0 cm) renal masses suitable for standard laparoscopic PN without ischemia. Patients with renal tumors up to stage T2 in the absence of nodal and systemic metastases were considered for the procedure, while those ones with significant cardiovascular and respiratory comorbidities or uncorrected coagulopathy were excluded. Even though patients with body mass index (BMI) < 30 were selected for this procedure during the early part of our learning curves, at present, we do not consider obesity as exclusion criteria.

Among all the articles found, we selected only those that were single-centre studies (not multicentre studies); we analysed only articles single-site surgical technique series (laparoscopic and robotic) that included information about tumour stage, tumour grade, mean tumour size, mean operative time, blood loss, transfusion rate, length of post-operative stay and complications. In addition the following data were collected: age, gender, BMI, intraoperative variables (number of additional ports), post-operative complications (Clavien classification), positive surgical margins, pain assessment at discharge [visual analogue scale (VAS) scale]; In the study incision length and patient subjective scar satisfaction were also evaluated[18]. In all the studies, all patients underwent renal ultrasonography and computed tomography scan before surgery, to give detailed information on tumour size, location, extent of parenchymal infiltration and proximity to the pelvicalyceal system.

Table 1 The surgical relevant data of all studies

Ref.	*n*	Robotic	Age (yr)	BMI	Mean tumor size (cm)	Mean operative time (min)	Mean EBL (mL)	Length of stay (d)	Mean ischemia time (min)	Transfusion rate (%)	Complication > Ⅲ grade clavien	Additional trocars % (diameter)	Positive margins	VAS	Conversion in MLS	Conversion in OS
Desai *et al*[20]	6	0	62	25	3	270	475	7.2	20	0	2	100% (6 mm × 2 mm; 1 mm × 5 mm)	0	-	-	-
White *et al*[21]	15	4	-	-	3.01	196	422	4.5	NA	26	0	13% (NA)	1	6	2	1
[2]Kaouk *et al*[16]	7	2	63.5	27.5	2.1	165	260	3.3	0 in 6 pts 16 in 1 pts	14	0	14% (NA)	1	1.35	-	-
Choi *et al*[15]	59	56	-	-	2.6	212	171	4.5	27.5	13	1	Most of the cases (12 mm)	2	-	2	2
Bazzi *et al*[22]	17	0	60.6	26.8	1.8	176.6	170.6	3.4	28.6	0	3	0	0	1.58	1	1
[2]Rais-Bahrami *et al*[23]	15 (14 pts)	0	57.9	29.3	2.3	167.3	293.3	2.7	24.6 (9 pts) 0 (6 pts)	0	2	0 (1 case converted LPN)	0	2.1	1	0
[1]Tiu *et al*[24]	67	67	52.4	23.2	2.4 (47)	178	271	4	24	10.64	0	Cases right 5	2	-	0	0
			51.9	24.7	5.4 (20)	197	408	5.3	31	10	0	mm-trocar	1	-	0	1
Schips *et al*[19]	21	0	58.4	25	1.8	111	196	4.4	0	0	2	50% (2 mm × 3 mm; 5 mm × 5 mm)	2	2.1	3	0
Springer *et al*[18]	14	0	52.5	26.2	2	120	165	4	0	0	0	76% (11 mm × 3 mm)	0	1	0	0

[1]Tiu uniforms procedures depending on the size of the neo-formations, in the first row showns formations < 4 cm in the second those > 4 cm; [2]In these cases, authors specify the number of procedures that executed without ischemia from those in which the removal executed with ischemia. BMI: Body mass index; EBL: Estimate blood loss; OS: Conversion in open surgery; LPN: Laparoscopic partial nephrectomy; NA: Not attempted; VAS: Visual analogue scale; MLS: Multiport laparoscopic surgery.

We selected studies that described both LESS-PN and R-LESS PN (with or without ischemia).

RESULTS

A PubMed search revealed 9 surgical series of LESS NSS describing 221 cases overall including the authors' updated experience[15,16,18-24]. No randomised or comparative clinical trials were found. The surgical relevant data are described in Table 1. The mean average age was 62 years with a mean BMI of 25. Overall, the mean tumour size was 2.35 cm, the mean operative time was 181 min (range 111-270). Fifty-eight point three percent of the cases were R-LESS-PN. The mean ischemia time was 23.6 min (range 31-16 min), 25.8% of the cases were done without ischemia.

Mean estimated blood loss was 296 mL (range 165-475 mL) and median hospital stay was 4 d (range 2-7.2 d).

Severe (≥ Clavien grade Ⅲ) postoperative complications occurred in 5.4% of patients (12/221).

In some surgical series of LESS-PN or R-LESS-PN conversion to multiport laparoscopic or Open Surgery (OS) was necessary. However, only 14/208 cases needed conversion.

Reviewing the literature the use of an additional trocar to either multiport laparoscopic surgery (10 cases) or OS (4 cases) is valid option during the LESS procedure. The majority of cases only one additional trocar was used.

Rha used an additional 8-mm trocar to lift the liver in procedures of the right kidney[25]. In another paper an additional 3-mm trocar placed in the majority of patients was used to better control haemostasis during the removal of the tumour[18]. Some authors however, like Bazzi *et al*[22] did not used it at all.

Regarding oncologic outcomes, surgical margins were positive in 4% (9/221). Out of these 7/9 had renal cancer cells at the level of the inked parenchymal excision surface (although in four cases the intraoperative frozen section was negative); the remaining 2/9 were benign lesions (one angiomyolipoma and one recurrent oncocytoma). In most of the articles the patients were discharged with minimal discomfort, as demonstrated by their pain assessment scores (median VAS = 1)[18,19,21-23].

DISCUSSION

During the last decade the use of high-tech devices has become more and more common in urological procedures; efforts are done in the development of minimally invasive surgery. The conventional laparoscopic surgery is now paving way to the new technologies including LESS[26].

In fact, robotic and laparoscopic LESS partial nephrectomy represents an attractive and minimally invasive treatment option for patients with small renal tumours. Although the use of an additional 5-mm subxiphoid liver retraction port for right-sided renal tumours was a deviation of the strict philosophy of LESS surgery; however, it has become an accepted practice[25].

Several studies have been performed to evaluate the efficacy and surgical feasibility of LESS in current clinical practice[24,25,27]. In the oncological arena Bensalah confirmed that LESS is safe, but revealed that the indication and tumor location, rather than margin status, were significant predictors of local recurrence with a mean follow-up of 37 mo[28].

The oncological and functional outcomes of R-LESS-PN has been published by Tiu *et al*[26]. In their work they evaluated 39 patients who underwent R-LESS-PN with a minimum of 2 years follow-up. They showed comparable results with other minimal invasive surgical options for the management of renal tumours. They concluded that were still to address the current challenge of R-LESS surgery before this technique might be considered as the standard of care[26].

The main limitations of LESS-PN are: lack of availability of dedicated tools, impossibility of triangulation of the instruments using conventional laparoscopic instruments, and limits in the range of movement, that causes inter-instrument interference both inside and outside the operative field[29].

For these reasons Stolzenburg *et al*[30] tried to improve efficiency moving on from articulating instruments to the curved (pre-bent) laparoscopic instruments. These procedures were performed using different ports and instruments proving the feasibility of the laparoscopic single-site surgery instruments with variable equipment, at least in the hands of experienced laparoscopic surgeons[30].

The introduction of robot-assisted techniques minimize some of these problems despite the current da Vinci system (Intuitive Surgical Inc, Sunnyvale, CA, United States), is not designed to be used in this way. The more common problems are instrument conflicts (internal or external), significant gas leak, and the insufficient tissue retraction due to the absence of the fourth robotic arm[31].

Nevertheless, the development of new devices for LESS (*e.g.*, prebent instruments, streamlined and flexible optics, and magnetic anchors) will surely reduce the technical difficulties that were reported when this technique was just beginning[32].

Song have shown that the recovery of renal function after partial nephrectomy is impacted by patient age, comorbidities, and baseline renal function, along with the amount and depth of parenchyma excised. Interestingly, these investigators have reported warm ischemia times to have no impact on renal function[33].

The goal of LESS should be the Trifecta achievement defined as the combination of warm ischemia time < 20 min, negative surgical margins, and no surgical complications[11].

In this respect, Buffi *et al*[34] observed a significant longer operative time and mean ischemia time in R-LESS-PN cases than with the multiport robotic partial nephrectomy procedure. They also observed that patients with increased tumour size, moderate and high Preoperative Aspects and Dimension Used for an Anatomic Classification and Radius/Exophytic/Nearness to collecting system/Anterior/Location scores, infiltration of the collecting system, and renal sinus involvement had an increased probability for trifecta failure[34].

Cost-efficacy is also an important issue that should be taken into account. Pini *et al*[35] have compared the real costs of the various procedures (PN, LPN, laparoscopic nephrectomy, N-LESS and LESS-PN). They analysed the intra and post-operative costs, concluding that the minimally invasive surgery is the most expensive in the intraoperative phase (use of materials, operating time, *etc.*), but less wasteful post-operatively (days of hospitalization, post-surgical complications). Unfortunately the German government (as Italian government) uses a prospective payment system based on diagnosis-related groups. This system calculates the cost encoding peri- and postoperative complications and hospitalization time, without any distinction of surgical approach, blood transfusions, need of perioperative Double J stenting and intraoperative frozen section. For this reason, the total cost remained almost unmodified among all groups that they analysed. In conclusion, they stated that local health systems should consider a subclassification with different reimbursement, which should incentive NSS and minimal invasiv surgery approaches[35].

The evidence available in the literature indicate that LESS-PN and RLESS-PN are feasible and associated with favourable reduced postoperative recovery. However, the prolonged learning curve with LESS is a major drawback. Continued innovation may allow single-port surgery to become more easily incorporated into standard practice.

COMMENTS

Background

During the last years it was developed a new minivasive tecHnique, laparoendosocopic single site (LESS) surgery, that is applied to small renal tumours. The purpose of this method is to be less invasive than usual one, because of its only one access point. Therefore this innovative approach should lead to a minor morbidity for patients and a more suitable cosmetic result, especially in young patients.

Innovations and breakthroughs

In this paper the authors assembled various articles, published all over the world, trying to offer a topic overview.

Applications

This technique could be used for all the small tumors. However, the prolonged learning curve with LESS is the major drawback.

Peer review

This is a reasonably well written review of LESS partial nephrectomy.

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P- Reviewer: Ilie CP, Levinson AW, Mazaris E, Salvadori M
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