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Laparoendoscopic single-site surgery for renal malignancies

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“The goal of performing ‘scarless surgery’ ... has been the driving force behind the development of laparoendoscopic single-site surgery and natural orifice transluminal endoscopic surgery.”

Laparoscopy has gained widespread popularity in urology as it provides many advantages for patients, including better cosmesis, less bleeding, diminished pain and faster recovery compared with open techniques. Nevertheless, the multiple incisions required for laparoscopy are still associated with complications, intermediate levels of discomfort and variable aesthetic outcomes [1]. To prevent complications and to further decrease convalescence associated with laparoscopic surgery, a novel technique, laparoendoscopic single-site surgery (LESS), has been developed [2].

The goal of performing ‘scarless surgery’, with little to no postoperative pain owing to the absence of abdominal wall trauma, has been the driving force behind the development of LESS and natural orifice transluminal endoscopic surgery (NOTES). Benefits of LESS include enhanced cosmesis with additional potential benefits, including decreased pain and shortened convalescence [3].

Attempts to perform urologic surgery through a single incision began in 2005 with a report by Hirano *et al.*, who performed a retroperitoneoscopic adrenalectomy [4].

Rane *et al.* were the first to report urological LESS, completing a nephrectomy for a nonfunctioning kidney and a ureterolithotomy [5]. In 2007, Raman *et al.* reported their experience using a single incision to complete three cases of nephrectomy [6].

Laparoendoscopic single-site surgery is certainly associated with several challenges and an advanced laparoscopic skill set is required. Difficulties encountered with LESS include:

- Lack of triangulation;
- Counterintuitive instrument movement (the instruments are at times crossed);
- Clashing of instruments;
- Challenging visualization and scope handling;
- Difficulty retracting with flexible instruments due to force dissipation.

“The literature is replete with case series on laparoendoscopic single-site surgery; however, they all suffer from the same basic flaws: small sample size, lack of long-term follow-up and lack of randomized studies.”

With increasing experience and enthusiasm, a greater number of urological procedures, both extirpative and reconstructive, have been performed using LESS. For upper-tract tumors, LESS is being used to perform cryotherapy, partial nephrectomy and radical nephrectomy, and to treat transitional cell carcinoma with nephroureterectomy. For the lower tract, LESS and robotic LESS prostatectomy and

cystectomy have been described [7,8]. The literature is replete with case series on LESS; however, they all suffer from the same basic flaws: small sample size, lack of long-term follow-up and lack of randomized studies.

This therefore leads to the following question: at present where does LESS stand as a minimally invasive treatment for renal malignancies?

In terms of clinical series, Goel and Kaouk reported six cases of single-site renal cryoablation [9]. They mention that cryoablation, with its limited requirement for dissection, is an ideal procedure with which to gain experience in LESS. Ponsky *et al.* reported their experience with LESS nephrectomy and nephroureterectomy. They used a Pfannenstiel incision for their access and in the case of the nephroureterectomy, they were able to perform an open ureterectomy and bladder-cuff removal through the access incision [10].

“...cryoablation, with its limited requirement for dissection, is an ideal procedure with which to gain experience in laparoendoscopic single-site surgery.”

Stolzenburg *et al.* reported their experience in ten patients undergoing LESS radical nephrectomy for renal tumors [11]. In this group all procedures were performed successfully with no positive margins. Sotelo *et al.* reported their stepwise experience with hybrid NOTES nephrectomy in the setting of renal cell carcinoma [12]. This was followed by a report by Alcaraz *et al.* detailing their experience with hybrid NOTES nephrectomy in 14 patients, ten of which were performed for renal cell carcinoma [13]. Recently, Derweesh *et al.* published a case series of advanced LESS in which six radical nephrectomies, two of which had a renal vein thrombus, and four partial nephrectomies were performed. Only one patient in the partial nephrectomy group required conversion to open surgery owing to failure to progress [14].

These studies suggest the feasibility of LESS for the management of renal malignancies; however, only two retrospective studies have attempted to compare LESS with conventional laparoscopy. Raman *et al.* compared 11 single-site and 22 conventional laparoscopic nephrectomies for various indications [15]. Nephrectomy was performed for malignancy in six out of 11 cases in the single-site cohort. No significant difference was found in most variables, including postoperative pain and hospital stay. Park *et al.* compared 19 patients who underwent LESS radical nephrectomy with 38 patients who underwent conventional laparoscopic radical nephrectomy with all cases performed for renal tumors [16]. In this study, the LESS cohort had a significantly decreased hospital stay and pain scale. There was no significant difference in complication rate in either study.

At the Cleveland Clinic (OH, USA), an extensive number of LESS procedures for renal neoplasms have been performed. Initially these surgeries were performed using laparoscopic or articulating instruments; however, with increasing experience, the da Vinci® Surgical System (Intuitive Surgical, CA, USA) has been utilized. Benefits of the da Vinci Surgical System for

LESS include easier articulation, 3D vision, motion scaling and tremor filtration. We feel that these features have the ability to improve ergonomics and range of motion during LESS, although the present system does require a somewhat larger incision of at least 4 cm.

Up to this point we have reported six radical nephrectomies, 15 partial nephrectomies and eight cryoablations for renal cell carcinoma, and seven nephroureterectomies for upper-tract urothelial carcinoma [17]. Only one patient undergoing partial nephrectomy had a focally positive margin. Tumor excision and renorrhaphy during partial nephrectomy is predictably challenging. Optimal initial candidates would have small, exophytic masses [18]. A novel single-site robotic platform will probably enter the marketplace soon and it is hoped that such technology will render excision and suturing more straightforward with smaller incisions required. At the present time, we advise that considerable LESS experience should be obtained before attempting more complicated and time-dependent oncologic and reconstructive procedures such as partial nephrectomy.

Returning to our original question of where does LESS stand as a minimally invasive treatment for renal malignancy, it appears to be a reasonable option but evaluation is ongoing. For those wishing to gain expertise with LESS techniques, specifically the unfamiliar working environment, various ports available and different approaches to resolving intraoperative difficulties (e.g., instrument collisions), preparation with a pelvic trainer and animate model should be encouraged. In terms of progression to clinical procedures, proper patient selection is the key. Especially in one's early experience, obese or tall patients, and those with an extensive prior surgical history should be avoided [19]. Ideal initial procedures to gain experience with LESS include oncologic surgery such as cryoablation and nephrectomy, or that for benign conditions such as cyst decortication or pyeloplasty.

“...considerable laparoendoscopic single-site surgery experience should be obtained before attempting more complicated and time-dependent oncologic and reconstructive procedures such as partial nephrectomy.”

We believe it is unlikely that there will be any difference in long-term cancer control between LESS cryotherapy or radical nephrectomy compared with conventional laparoscopic techniques. The same may not necessarily hold true for partial nephrectomy, where complexity of tumor excision, reconstruction, and limiting warm ischemia time may affect outcomes. Great preparation and careful selection should be employed prior to performing LESS partial nephrectomy presently and, at the very least, these procedures should be reserved for surgeons who are very experienced in LESS techniques.

As time passes, progress toward less invasive therapies is inevitable. Surgically, the last two decades have seen the replacement of large incisions with port sites and the substitution of knives for robotic instruments and needle probes. With each new technique there is an understandable lag for data collection, as well as technology development. As evidence demonstrated equivalent

oncologic results for upper-tract urologic laparoscopy, these techniques eventually replaced their open equivalents at many centers. LESS, existing only 3 years, is a relatively nascent technique yet early results suggest that it may provide the robust outcomes of a surgical option with the aesthetic results of percutaneous ablative techniques.

“Great preparation and careful selection should be employed prior to performing LESS partial nephrectomy...”

For long-term acceptance and widespread adoption of LESS, a technology revolution is needed. Only surgeons quite experienced in pure laparoscopy have adopted LESS owing to the present technical challenges of these procedures. We believe that further instrument development, and specifically introduction of a single-site robotic platform, will probably level the playing field

and allow for more surgeons to offer LESS to patients. With these advances it is likely that the development and increased clinical use of NOTES will not trail far behind.

Ultimately, in order to accurately determine the role of LESS in the management of renal malignancy, randomized controlled trials are emerging, which will not only address the efficacy and safety of these procedures but also help define what benefits truly exist. For traction of these procedures, tangible benefits beyond patient interest need to be established.

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The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

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