



## Review

## Roles of NOTES and LESS in management of small renal masses

Dae Keun Kim <sup>a, b</sup>, Young Eun Yoon <sup>c</sup>, Woong Kyu Han <sup>c</sup>, Koon Ho Rha <sup>c, \*</sup><sup>a</sup> Department of Urology, CHA Gangnam Hospital, CHA University, CHA Medical School, Seoul, Republic of Korea<sup>b</sup> Department of Urology, School of Medicine, Graduate School, Hanyang University, Seoul, Republic of Korea<sup>c</sup> Department of Urology, Urological Science Institute, Yonsei University College of Medicine, Yonsei-ro 50-1, Seodaemun-gu, Seoul 120-752, Republic of Korea

## HIGHLIGHTS

- LESS and NOTES are innovative techniques for treatment of small renal masses.
- Further study is needed to clarify the advantages.

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## ABSTRACT

**Introduction:** Over the last 2 decades, open surgery has been largely displaced by laparoscopic surgery for the treatment of renal masses. Recently, minimally invasive surgical techniques, such as laparoendoscopic single-site surgery (LESS) and natural orifice transluminal endoscopic surgery (NOTES), have been developed for such purpose.

**Methods:** In the present literature review, the current status of treatment for small renal masses was investigated. The advantages and disadvantages of LESS and NOTES are presented to confirm the feasibility and reproducibility of these techniques.

**Results:** LESS significantly reduces pain and offers excellent cosmetic outcomes with comparable oncological and perioperative results, and NOTES offers the potential for surgery by various approach without any transcutaneous abdominal incision in management of small renal masses.

**Conclusion:** When the technical limitations are overcome, clinical application of LESS and NOTES is expected to increase. Further prospective and comparative studies are needed to clarify the application of these new techniques.

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## 1. Introduction

Since the emergence of laparoscopic nephrectomy, the laparoscopic approach has been established as the gold standard for renal masses requiring surgical treatment [1–4]. Conventional laparoscopic surgery for renal masses usually requires 3 to 4 abdominal incisions for port placement. For a more minimally invasive approach, surgeons can use one incision for a trocar or a natural orifice requiring no abdominal incision. Recently, laparoendoscopic single-site surgery (LESS), which requires single-site access, has become attractive for various procedures [5,6]. Abdominal targets also have been approached in a transluminal way (vagina, anus, urethra, or mouth), leaving the patient without any scar. Natural

orifice transluminal endoscopic surgery (NOTES) and LESS are new developments in the evolution of minimally invasive surgery. NOTES offers the potential for surgery without any transcutaneous abdominal incision, while LESS appears to offer a natural intermediate step toward a NOTES approach, which may prove more practical for many applications, and these techniques share the common underlying premise that reducing the number of transcutaneous access ports may benefit patients in terms of port-related complications, recovery time, pain, and cosmesis by potentially performing a scarless surgery [7]. Recently, for management of renal masses, both LESS and NOTES have been performed and studied in various centers with comparable results. Ultimately, each approach will need to demonstrate its advantages and will require sufficient acceptance for management of small renal masses. Therefore, in the present literature review, we investigated the development of LESS and NOTES for treatment of renal masses.

\* Corresponding author.

E-mail addresses: [kdg070723@gmail.com](mailto:kdg070723@gmail.com) (D.K. Kim), [urologistyoon@yuhs.ac](mailto:urologistyoon@yuhs.ac) (Y.E. Yoon), [hanwk@yuhs.ac](mailto:hanwk@yuhs.ac) (W.K. Han), [khrha@yuhs.ac](mailto:khrha@yuhs.ac) (K.H. Rha).

## 2. Evidence acquisition

We performed a literature search using the PubMed database. The search string was defined by a combination of keywords including “single-site surgery,” “laparoendoscopic,” “LESS,” “renal mass,” “natural orifice surgery,” “natural orifice transluminal endoscopic surgery,” “NOTES,” “nephrectomy,” and “partial nephrectomy.” Two authors reviewed the retrieved abstracts and selected the articles reporting LESS and NOTES for treatment of renal masses. Any discrepancy was solved by an open discussion. The search was limited to articles in English, and, for the review process, a total of 55 representative papers (LESS and NOTES) were selected and described in the present review.

## 3. LESS

### 3.1. History and evolution

Hirano et al. reported the first single-incision urologic surgery in 2005 [8]. They used a resectoscope tube and standard laparoscopic instruments to show the feasibility of retroperitoneoscopic adrenalectomy. Then, in 2007, Raman et al. performed LESS transumbilical nephrectomy in 3 patients following an initial porcine feasibility model [6]. Since then, entire clinical series have reported such urologic procedures [9].

### 3.2. Equipment

During the infancy of LESS, there was a need for manufacturing new single-site multichannel access ports for the introduction of instruments, and the existing conventional laparoscopic instruments were associated with instrument clashing, sword crossing, and a very limited range of movement due to the lack of triangulation, which resulted in significantly increased surgical difficulty [10]. The introduction of specially designed access ports and prebent, articulating instruments for LESS made the procedure easier and more time-efficient.

#### 3.2.1. Access devices

Application of an Alexis retractor in its structural design allows overextension of the incision and enlargement of the working surface for use of a homemade single-port platform with of surgical glove [11–13] (Fig. 1). Currently, there are many commercial ports available for LESS, including the SILS port (Covidien, Dublin, Ireland), which provides 3 channels with a 5- or 12-mm diameter.

Another port, GelPort (Applied Medical, Rancho Santa Margarita, CA, USA), provides triangulation of the laparoscopic instruments through its rubber sealing cap. The Quadport+ (Olympus, Tokyo, Japan) offers one more port for entry and a wide variety of channel diameters (5, 10, 12, or 15 mm). Recently, Intuitive Surgical developed a new single-site multichannel access port with 4 cannulas and an insufflation valve; one cannula is for an 8.5-mm robotic endoscope, 2 curved cannulas are for robotic instruments, and one cannula is for a 5- or 10-mm bedside-assistant port. The curved cannulas are integral to the system as their configuration allows the instruments to achieve triangulation to the target by crossing them through the access port (Fig. 2).

#### 3.2.2. Instruments

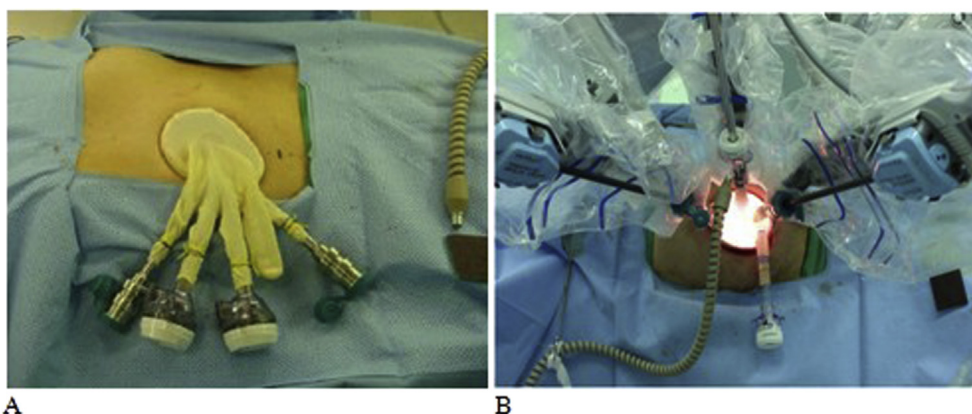
For the articulating instruments, better intraoperative ergonomics are present at the expense of insufficient joint forces for secure knot tying and tissue traction [14]. Autonomy Laparo-Angle (Cambridge-Endo, Framingham, MA) and Roticulator (Covidien) instruments provide 7 degrees of freedom with 360° of rotation around their axis according to an articulating mechanism that allows deflection of the tip of the instrument. Prebent instruments, including the HIQ LS hand instruments (Olympus) and S-portal series (Karl Storz, Tuttlingen, Germany), have fewer degrees of freedom compared with their articulating counterparts. Various LESS equipment are presented in Table 1.

#### 3.2.3. Optics

The EndoEye series (Olympus) and EndoCAMEleon (Karl Storz) are 10-mm laparoscopes with a sensory chip rotating within the tip of the instrument. In the latter design, the flexible shaft of the laparoscope is avoided, resulting in a possible advantage in longevity of the instrument. In addition, Park et al. [15] introduced the magnet anchoring and guidance system (MAGS), which is composed of an intra-abdominal camera that can be manipulated via an extracorporeal magnetic handle. The improvement of surgeon's ergonomics and technical challenge by MAGS was investigated with comparing MAGS camera and conventional laparoscope [16].

### 3.3. LESS nephrectomy

The first LESS radical nephrectomy in a human was performed by Raman et al. on a patient with a 4.5-cm central-enhanced renal mass [6]. The mean operating time was 133 min and there were no postoperative complications, however, instrument collision was a



**Fig. 1.** A, 2, 12-mm ports and 2, 8 mm robotic trocars were placed through homemade single port system. B, 1 camera port and 2, 8 mm robotic trocars and 1 assistant port were placed through homemade single port and docked to robotic system.

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