

# A Novel Totally Internal Laparoscopic Liver Retractor

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**Introduction:** Minimally invasive surgery is still in evolution. Throughout the past two decades numerous devices have been developed to enable safer and faster procedures, including anastomosis creating devices, energy sources, and superior imaging. However, retraction capabilities were put aside and currently, organ laparoscopic retraction is based on standard laparoscopic tools. In the era of minimizing the number of ports and shrinking their size, our aim was to develop internal retraction device that could be placed in the peritoneal cavity through a standard trocar, positioned for adequate retraction, and left in place for the entire procedure. These devices would obviate the need for inserting ports dedicated for retraction only and hence contribute to the reduction of the number of incisions. Herein, we present our initial experience with a novel internal liver retractor.

**Materials and Methods:** The Endolift retractor is a simple telescopic rod that has anchoring claws at each end. It can be inserted using 5 mm standard trocar using a dedicated applier and anchored to the peritoneum beside the liver edges thereby lifting the undersurface of the liver and exposing the organs underneath. To achieve retraction of the left lateral segment, the Endolift retractor is anchored lateral to the right diaphragmatic crus on 1 side and lateral to the falciform ligament on the other.

**Results:** A total of 14 operations were performed using the Endolift retractor for liver retraction including antireflux procedure, robotic-assisted Heller's myotomy, bariatric procedures, and bile duct exploration. The left lobe of the liver was adequately retracted and enabled access to the operating field. Repositioning was easily performed with progression of the surgery when necessary.

**Conclusions:** Internal retraction devices such as the Endolift retractor for liver retraction are one step further in minimizing trauma to the abdominal wall during minimal invasive surgery. It obviates the need for extra incisions, frees up the surgeons' hands, and may enable performing complicated laparo-endoscopic single-site laparoscopy and natural orifice transluminal endoscopic surgery.

**Key Words:** laparoscopy, liver, retraction, internal, LESS, NOTES, single port

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Minimal invasive surgery has become the leading modality for performing operations at the hiatus area. Laparoscopy provides the surgeon with an excellent view.

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However, retracting anatomic structures such as the liver is crucial. Evolution of minimally invasive surgery toward even less invasive techniques has influenced the development of advanced surgical devices. Retraction of the liver and specifically its left lobe allows safe and accurate surgery. Retraction is achieved either externally or internally. Commercially available external retractors such as the Nathanson's flex arm (Mediflex Surgical Products, Long Island, NY),<sup>1</sup> or the snake liver retractor (Snowden Penser Inc., Tucker, GA) provide excellent exposure but necessitates a dedicated abdominal wall incision. Internal retractors are inserted into the peritoneal cavity during laparoscopic surgery while utilizing existing trocars and obviating the need for an additional trocar or skin incision dedicated only for retraction. Interestingly, after years without any evolution in laparoscopic retraction techniques during the last 2 years we were faced with several publications regarding promising but improvised internal retractors such as suturing penrose drains beneath the liver<sup>2</sup> or securing a Lone Star retractor hook (Lone Star Medical Products, Stafford, TX) to laparoscopic bulldog clamp.<sup>3</sup> Most of these retracting techniques include performing small incisions through the abdominal wall or placing sutures through the liver and only few provided retraction without any tissue avulsion. It seems that the introduction of both laparo-endoscopic single-site laparoscopy (LESS and natural orifice transluminal endoscopic surgery (NOTES) modalities have accelerated this innovative process. Herein, we describe a technique for retraction of the liver using a novel surgical device called the EndoLift (Virtual Ports Inc., Caesarea, Israel). This device was initially developed for liver retractions. We have found this retractor to provide excellent exposure while its installation is easy to learn, quick, and safe.

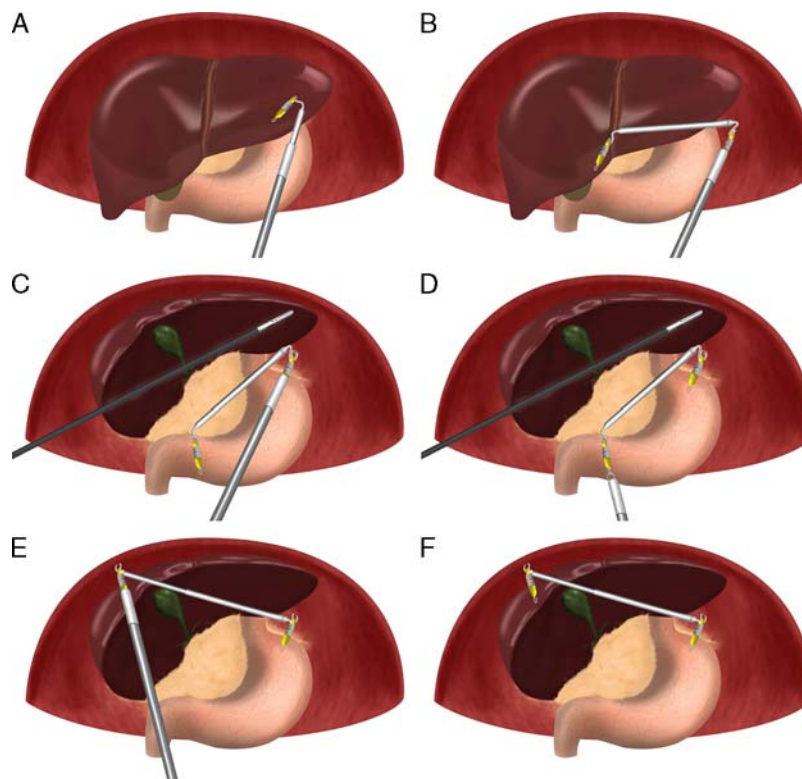
## MATERIALS AND METHODS

### Surgical Procedure

The EndoLift retractor is a disposable telescopic rod with anchoring claws at each end (Fig. 1). It is introduced



FIGURE 1. The EndoLift retractor device.



**FIGURE 2.** “Step-by-step” sketches illustrating the installation of the EndoLift retractor device. A, Introducing of the EndoLift retractor into the peritoneal cavity by using its applicator. B, The EndoLift retractor is headed toward the left crus of diaphragm. C, The EndoLift retractor’s claws anchored on the diaphragm. A laparoscopic grasper device aids in elevating the liver in order to achieve a proper location for the retractor. D, The applicator disconnects from 1 side of the rod and connects to its other side in order to anchor it on the right part of the diaphragm. E, The applicator pushes the anchoring claws of the EndoLift retractor toward the right side of diaphragm while elevating the liver superiorly. F, The surgeon disconnects the applicator and withdraws it from the peritoneal cavity, leaving the liver suspended by the EndoLift retractor.

into the peritoneal cavity through a 5-mm trocar by means of a proprietary applicator tool (Fig. 2). We use a reusable applicator to attach the EndoLift retractor to both sides of the diaphragm to achieve retraction of the left liver lobe (Fig. 3). After installation, the applicator is removed and the port is freed for use by other instruments. Usually, we anchor the left part of the EndoLift retractor anterior to the diaphragmatic origin of the right crus. The right side of this device is attached medially and superior to the falciform ligament. Pushing this ligament cranially augments the retraction force and provides further stability of the retraction. The device is easy to use and necessitates only a minimal time for learning. In morbidly obese patients in case the surgeon is facing a liver with an enlarged left lobe, it may be useful to place two EndoLift retractors side by side to achieve maximal retraction capability. During the operation, it is possible to reposition the EndoLift retractor as needed, however, usually retracting the left lateral segment of the liver adequately in the beginning of the procedure obviates this need. Retraction of the right liver lobe is achieved by anchoring the EndoLift retractor on the diaphragm under the right liver lobe on one side and over the falciform ligament on the other side. This way, the entire liver is suspended away from the hepatic flexure, kidney, and duodenum thereby enabling procedures on the kidney, adrenal, duodenum, and bile duct. At the end of the procedure, the applicator is introduced once again in order to withdraw the EndoLift retractor.

### Our Experience With the EndoLift Retractor

We introduced this technique into human surgery after practicing and gaining sufficient experience with the device on animal models and cadavers. Following Food and Drug Administration approval, we performed the first series of human operations using this retractor. We herein report our initial experience with the first 14 patients (Table 1). In



**FIGURE 3.** The EndoLift retractor device has elevated the left lobe of the liver and exposed the hiatal area.

**TABLE 1.** Description of Total 14 Operations in Which we Utilized the EndoLift Retractor

Type of Operation	No. Patients (n = 14)
Laparoscopic partial gastrectomy	1
Laparoscopic antireflux procedure	1
Robotic-assisted Heller myotomy	2
Laparoscopic bile duct exploration	1
Laparoscopic sleeve gastrectomy	7
Laparo-endoscopic single-site laparoscopy sleeve gastrectomy	2

all operations except one, the exposure of the surgical field achieved by this device was comparable or better than the usual exposure we achieve using standard retractors and enabled performing the operation safely without introducing any other retractors. One patient had an exceptionally large liver, which mandated the use of a standard liver retractor. Early in our experience we also placed two Endolift retractors in two patients to achieve maximal retraction of a floppy liver lobe but with experience we learned how to position one retractor for similar livers. There were no intraoperative or postoperative complications (intra-abdominal bleeding or diaphragm perforation) related to the device. The positioning time improved with experience and reached approximately 1 minute.

## DISCUSSION

Conventional liver retractors such as: the Nathanson Flex Arm, Snake Liver Retractor, or simply any other blunt laparoscopic straight instrument are currently used in order to lift the lateral aspect of the left liver lobe for retraction purposes. However, these surgical instruments require additional incisions and a dedicated trocar. As minimally invasive surgery advances, the need for internal retractors has become more prominent. Our aim is to reduce the number of trocars while preserving the exposure and the ability to perform safe and reproducible operations. Over the past few years, new methods of internal liver retraction have been proposed. Some techniques involve penetration of the abdominal wall by sutures. Woo et al<sup>4</sup> described liver suspension using two gauze pads secured to the pars condensa by two surgical clips and passing prolene sutures between the gauze pads through the anterior abdominal wall to be tied on the external abdominal wall. A similar technique was used by Shabbir et al,<sup>5</sup> a Vicryl 2/0 suture was passed through the pars condensa through the avascular portion of the falciform ligament and tied on the external surface of the abdominal wall while placing a gauze to protect the liver. By this technique, a combined retraction of the left liver lobe and the falciform ligament were achieved. Other techniques do not involve penetration of the abdominal wall, however, utilize different devices not for their intended use. Huang et al<sup>6</sup> developed a V-shaped liver suspension technique by using a Penrose drain and a

laparoscopic clip applier. The Penrose was stapled to the pars condensa of the lesser omentum and to the parietal peritoneum. Galvani et al<sup>3</sup> described a technique in which a Lone Star retractor's hook attached to a bulldog clamp, the bulldog clamp was attached to the pars flaccid, and the Lone Star hook retracts the liver and attached to the parietal peritoneum or the falciform ligament.

We present our experience with the EndoLift retractor a novel surgical device, which was specifically developed and designed for liver retractions. The device enables retraction of the left lobe of the liver in different procedures of upper gastrointestinal tract or esophageal hiatus, and of the right liver lobe for operations of the duodenum, biliary tract, and kidney.

The EndoLift retractor is the only available instrument that was developed specifically for liver retraction and several advantages can be observed. The application is through a 5-mm trocar that can be used as an operating trocar after positioning the EndoLift retractor. This internal retractor can be positioned in standard laparoscopic surgery, laparo-endoscopic single-site laparoscopy, natural orifice transluminal endoscopic surgery, and robotic surgeries. It does not require any skin incision, suturing, or other manipulation. The application is simple and safe with minimal hazard to structures using two small anchoring claws. These claws have already been used successfully with another internal retractor device the EndoGrab (Virtual Ports Inc.) designed for retraction of the gallbladder.<sup>7</sup>

The EndoLift retractors were used in a variety of procedures and included morbidly obese patients with enlarged fatty liver. Although, large fatty liver poses a difficulty in retraction for proper exposure, by using the EndoLift retractor we could achieve adequate exposure despite these difficulties.

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