Hand-Assisted Laparoscopic Surgery

Eduardo M. Targarona, MD, PhD; Ester Gracia, MD; Manuel Rodriguez, MD; Gemma Cerda, MD; Carmen Balague, MD, PhD; Jordi Garriga, MD; Manuel Trias, MD, PhD

**Hypothesis:** Hand-assisted laparoscopic surgery (HALS) has been proposed as a useful alternative to conventional open or laparoscopic surgery. However, most information is fragmented and comes from specific or selective indications. To assess the current situation of HALS, a general overview of the fields of application, results, and quality of the evidence of these results is necessary.

**Data Sources:** Current English-language literature review.

**Study Selection:** Case reports, series, and opinion articles on HALS.

**Data Extraction and Synthesis:** Evaluation of the type of study and results. Most of the articles are short case series. Only a few comparative or randomized comparative trials on HALS for splenectomy and colectomy have been published.

**Conclusions:** Hand-assisted laparoscopic surgery seems to be a promising technique that has been applied with success in a wide range of digestive tract-related surgical procedures. The main role is to help in difficult cases before conversion is necessary or for training unskilled surgeons, and not as an alternative to pure laparoscopic surgery. However, not enough evidence-based data are available to know exactly the final outcome of this technique in general surgery. Prospective randomized trials with established open or laparoscopic procedures are lacking, and these trials are needed to support the final role of HALS.

Arch Surg. 2003;138:133-141

The use of videolaparoscopy has been one of the most important steps forward in general and digestive tract surgery in recent years. Over the last decade most intra-abdominal surgical procedures have been shown to be technically feasible using a laparoscopic approach. However, practitioners of laparoscopic surgery (LS) inevitably lose the sense of depth and their perception of tactile feeling may also be altered by the use of longer instruments, which may significantly impair their hand-eye coordination. Surgeons must, therefore, develop a range of new operative skills in addition to those required in open surgery and be aware that the performance of complex surgical maneuvers will be more difficult.1

See Invited Critique at end of article

During the early 1990s, many surgeons rather hastily predicted that LS would replace the conventional open approach. However, 14 years after the first laparoscopic cholecystectomy, and after a globalized learning curve that has included the development of what is known as “advanced LS,” surgeons have reached a stage in which the terms “conversion” and “selection” are part of the laparoscopic glossary. However, often selection or conversion is not because of the technical or anatomical impossibility of performing the procedures (for instance, in cases of dense adhesions or local advanced disease), but because of the difficulty of performing certain steps in the laparoscopic procedure, such as the exposure of the dissection area or the manipulation of a bulky specimen.

As advanced procedures have developed, some authors have proposed the concept of hand-assisted laparoscopic surgery (HALS), a technique that was, for the most part, rejected by the surgical community because it violated the fundamentalist principle of minimal invasion and because the insertion of the hand without the help of a mechanical seal to maintain the pneumoperitoneum was impracticable owing to the loss of gas and the direct contact of the surgeon’s arm with the abdominal wound.
In recent months, however, opinions regarding HALS have changed, in particular because of the emergence of devices designed specifically to maintain the pneumoperitoneum while the hand is inserted intra-abdominally.\textsuperscript{9-15} Another factor that has encouraged the use of HALS is the clear underdevelopment of advanced LS in certain areas such as colorectal surgery owing to the procedure’s technical difficulty; some authors\textsuperscript{10-15} have proposed HALS as an alternative. Hand-assisted laparoscopic surgery may also be justified in cases in which the laparoscopic procedure requires an accessory incision to retrieve the specimen, as in cases of colectomy or splenectomy for massive splenomegaly. The questions to be answered are whether HALS maintains the minimally invasive features of conventional LS, and whether it contributes to the technical development of LS.

CONCEPT

Hand-assisted laparoscopic surgery is an alternative laparoscopic approach in which a minilaparotomy is planned and performed to enable the surgeon to introduce his or her hand while the pneumoperitoneum is maintained and the dissection maneuvers are performed under videendoscopic control. The insertion of the hand restores the tactile feeling and the sensation of depth, and facilitates the exposure, traction, and retraction maneuvers during the procedure.

HALS DEVICES

The simplest way to perform HALS is to insert the hand through a minilaparotomy performed for that purpose. However, it is difficult to keep the seal tight and to avoid loss of gas; in addition, the movements of the arm and the hand are limited.

Three different devices are available for HALS (Figure 1).\textsuperscript{16} One type is a glove fixed to a circular platform that adheres to the surface of the skin, around the incision (Dexterity Inc, Roswell, Ga; or Intromit; Medtech Ltd, Dublin, Ireland). This device has the drawback of requiring adherence to the skin, which must be well prepared; adhesive substances are needed, and the device itself is easily lifted from the skin by the wound fluid. There are also devices with 2 elements (Hand Port; Smith & Nephew, London, England) (Figure 1A). The inflatable circular base adapts to the inner contour of the abdominal wall wound and is attached to a sleeve that is fixed to the surgeon’s arm, which allows the insertion and withdrawal of the hand. This device is comfortable and easy to install, but the fact that the sleeve cannot be changed prevents the use of the other arm or the hand of the assistant. Third, there are single-piece devices that adapt to the inner contour of the wall incision and permit the interchange of hand insertion, either mechanically (LapDisc; Hakko-Medical, Tokyo, Japan) (Figure 1B) or by inflation (Omniport; Advanced Surgical Concept, Dublin, Ireland).
cepts, Dublin) (Figure 1C and D). Some special surgical instruments have been designed for HALS. These instruments may help some delicate steps of surgical procedures such as those used in splenic or kidney vessel dissection.17

A procedure derived from HALS is finger-assisted LS (fingerscopy). By introducing a finger through a trocar wound the surgeon can free adherences or palpate and identify structures in situations such as appendectomy.18-20

ADVANTAGES

The obvious advantage of HALS is that it recovers the tactile feeling and improves hand-eye coordination despite the fact that the operation is performed under videoscopy. The recovery of tactile feeling shortens certain dissection maneuvers, avoids unnecessary movements, favors the smooth traction and exposure of structures, and facilitates the control of unexpected or difficult situations such as hemorrhage or the handling of a voluminous or adherent specimen. All of these advantages enhance the efficiency of the endoscopic procedure.

DISADVANTAGES

The main drawback of HALS is that it requires an additional incision, thus increasing trauma. For this reason, the best indications are those that involve the performance of a minilaparotomy to extract the specimen. The HALS technique requires a new operative strategy to capitalize on the presence of the hand being inside the abdomen, and the scope and the trocars must be correctly placed (Figure 2 and Figure 3).21-24 Furthermore, the hand takes up space inside the abdomen and may hamper certain maneuvers, particularly if the patient is thin or if the surgeon's hand is large. Hand-assisted laparoscopic surgery may also induce hand fatigue in long or complicated procedures.

ELECTION OF INCISION SITE FOR PLACEMENT OF THE HALS DEVICE

The choice of incision site is likely to depend on whether the intra-abdominal hand is the surgeon's or the assistant's. If it is the surgeon's, the nondominant hand is used; if it is the assistant's, the dominant hand is used. If it is the surgeon's hand that is introduced, it should not impair the visual field of the scope, so as to permit adequate triangulation over the target organ manipulated by the hand. In addition, the hand should not be placed over the structure to be dissected because this may impair the manipulation of the organ. When the procedure includes an accessory incision to extract the specimen (eg, in splenectomy for splenomegaly) or to perform the anastomosis (eg, in colectomy), the hand may be introduced through the anatomical site at which the incision is performed. If it is the assistant who introduces the hand, the accessory incision may be made far away from the introduction points of the operative trocars (a Pfannenstiel incision).22,23 In some situations the incision should be made in a multifunctional site (for instance, in the periumbilical midline, for a subtotal colectomy).

INDICATIONS

Hand-assisted laparoscopic surgery has been applied in many clinical situations, and its safety and efficacy have been amply demonstrated (Table 1). Two multicenter series that included multiple diagnosis and complex procedures have underlined its efficacy and the low incidence of conversion; surgeons interviewed in those studies stated that HALS definitely facilitated the procedure (58% of the surgeons considered that HALS reduced operation time and 88% that the intra-abdominal hand was helpful).25,26 Furthermore, immediate postoperative evolution was similar to conventional LS procedures. This suggests that HALS maintains the advantages of LS. However, few comparative studies with conventional LS or open surgery have been performed,27-29 and more are needed before we are able to confirm the advantages or drawbacks of this new procedure.

Hand-assisted laparoscopic surgery should be considered a priori as an aggressive surgery because (1) it requires a minilaparotomy incision at the beginning of the procedure, (2) this incision is stretched by the HALS device, and (3) the area of manipulation and traction is greater than in other procedures that use 5- to 10-mm instruments. In a prospective, randomized trial compar-
ing HALS with laparoscopic colectomy, increases in C-reactive protein and interleukin 6—used as tissue injury markers after HALS—indicated that HALS is more invasive than conventional laparoscopic colectomy. These aspects should be considered in any discussion of the advantages of HALS surgery.

Esophagogastric Surgery

Hand-assisted laparoscopic surgery has been applied to perform gastrolysis and gastric tube insertion during esophagectomy. It has also been used for transhiatal esophagectomy without thoracotomy and giant hiatal hernia repair, and for total or partial gastrectomy. The accessory incision may be used to perform the anastomosis and to restore digestive continuity. In a series of 60 patients Tanimura et al showed that HALS partial gastrectomy was followed by a better immediate outcome, and the oncological results were similar to those found after conventional open gastrectomy.

Surgery for Morbid Obesity

Since 1993, many laparoscopic techniques for treatment of morbid obesity have been described including vertical banded gastroplasty, gastric bypass, and adjustable gastric banding. All these techniques have also been performed with the help of HALS. Authors report a significant reduction of operative time, but comparative randomized trials with conventional LS techniques are lacking, and the potential source of morbidity of the accessory incision is unknown. Several experiments have shown the feasibility of vertical banded gastroplasty with a mean time of 100 minutes and a postoperative stay of 3.9 days. Hand-assisted laparoscopic surgery—assisted gastric bypass entails an operative time of 205 minutes and a hospital stay of 5 days. However, a comparative trial of HALS gastric bypass with open gastric bypass did not showed differences in operative time, morbidity, or late incisional hernia. There are no comparative studies with conventional LS, and the use of pure laparoscopic techniques is associated with a satisfactory result.

Colorectal Disease

The application of HALS in this area of surgery makes more sense because a mini-incision is required at the end of the procedure to perform the anastomosis, and because this kind of surgery involves procedures in several parts of the abdominal cavity and the manipulation of a large specimen. These features have delayed the development of LS in this area. Hand-assisted lap-
Laparoscopic surgery has been used for segmental resection of the colon, anterior resection of the rectum, total colectomy, reversal of Hartmann procedure, rectopexy, and abdominoperineal resection; its advantages include the easier manipulation of the organ (exploration, dissection, and colonic mobilization), and better control of hemorrhagic accidents, thus reducing the conversion rate. As far as malignant disease is concerned, the greatest advantages that HALS offers are the detection of metastatic lesions and the local staging of tumors. In a study comparing the number of maneuvers and movements in HALS with those in laparoscopic colectomy, HALS was found to reduce the number of unnecessary maneuvers. Two prospective, randomized trials comparing HALS and conventional laparoscopic colectomy reported only a moderate reduction (about 15 minutes) in the duration of the procedure, even though conversion from conventional LS to HALS made it possible to finish the procedure in 4 patients, who would otherwise have been converted to open surgery (Table 2). Both trials confirmed that HALS colectomy maintains the advantages of the pure laparoscopic approach, that is, bowel movements, refeeding, and hospital stay. One of these studies ruled out the intraperitoneal mobilization of malignant cells, and the pathologic features of the specimen (the size and number of lymph nodes) were similar in the 2 studies (Table 2). An interesting indication for HALS is in cases of diverticular disease because of the intensity of the adhesive reaction of the diseased sigmoid colon.

The HALS technique can also be used in rectal cancer. Pietrabissa et al used the procedure in a series of 16 patients who had tumors between 2 and 8 cm from the anal verge, below the peritoneal reflection. Operative time was 238 minutes; there were no conversions, and the mean postoperative stay was 5.6 days.

### Table 2. Results of 2 Prospective Randomized Trials Comparing Laparoscopic Colectomy With HALS Colectomy

<table>
<thead>
<tr>
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<th>Targarona et al²⁴</th>
<th>HALS Study Group²⁷</th>
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<tr>
<td></td>
<td>Laparoscopic</td>
<td>HALS</td>
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<tr>
<td></td>
<td>Colectomy Group</td>
<td>Colectomy Group</td>
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<tr>
<td>(n = 27)</td>
<td>(n = 27)</td>
<td>(n = 18)</td>
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<td>Age, y</td>
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<td>70</td>
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<tr>
<td>Sex, M/F</td>
<td>18/5</td>
<td>20/7</td>
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<tr>
<td>No. of patients with benign malignant disease</td>
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<td>5/22</td>
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<tr>
<td>No. of patients with right-sided and left-sided colectomy</td>
<td>11/16</td>
<td>12/15</td>
</tr>
<tr>
<td>Conversion</td>
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<td>2/27</td>
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<tr>
<td>Operative time, min</td>
<td>135</td>
<td>120</td>
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<td>48</td>
<td>48</td>
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<tr>
<td>Postoperative refeeding, h</td>
<td>48</td>
<td>72</td>
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<tr>
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<td>5</td>
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<tr>
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<td>2</td>
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<tr>
<td>Length of hospital stay, No. (range) of days</td>
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<tr>
<td>Length of specimen, mean (range), cm</td>
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</tr>
<tr>
<td>Lymph nodes, No. (range)</td>
<td>11 (2-35)</td>
<td>12 (5-29)</td>
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Abbreviation: HALS, hand-assisted laparoscopic surgery. Ellipses indicate not applicable.

### Hepatic Surgery

Few authors have attempted HALS hepatic surgery, but initial results are encouraging in the hands of skilled hepatobiliary surgeons (Table 3). Procedures include segmentectomies, left-sided hepatectomies, cryotherapy of liver metastasis, and liver resection under vascular control.

### Pancreatic Surgery

Tumor staging for pancreatic cancer, proximal, and distal pancreatectomy as well as pseudocyst digestive diversion or endocrine islet tumor enucleation have been reported, but the lack of experience prevents one from drawing definitive conclusions. Cuschieri and Gagner and Gentileschi have described good results in pancreatic surgery; distal pancreatic resection is one of the best indications for HALS.

### Splenectomy

Splenectomy is the most widely accepted indication for the laparoscopic approach, including cases of splenomegaly, despite the fact that splenectomy with intra-abdominal manipulation was first described by Kuminsky et al in 1995 and others. Anecdotal reports have shown advantages in certain difficult cases such as Hodgkin disease associated with node sampling, hydrad cysts of the spleen, or splenic metastasis. Two series have analyzed the potential advantages of HALS for LS, but most of the patients operated on had normalized spleens, and the results in terms of morbidity or length of hospital stay were close to those of standard LS. Gossot et al compared HALS with LS performed with the patient in lateral decubitus and a pos-
terior approach to the vessels, finding results similar to those of conventional LS and lesser blood loss. In addition, in a multicenter series of HALS in normal-sized spleens, Meijer et al found no evident improvement over the results of standard LS and noted the disadvantage of the accessory incision. A personal preliminary opinion seems to be that HALS is not indicated in cases with normal-sized spleens. Laparoscopic surgery for normal-sized spleens is a difficult but well-systematized and reproducible LS procedure, and the surgeon’s efforts should probably be addressed to mastering the pure laparoscopic procedure. Hand-assisted laparoscopic surgery can be considered a technical aid in cases in which conversion is required owing to intraoperative complication, an unclear anatomy, or an unusual circumstances (ie, pregnancy) (Table 4).86

However, the manipulation of an enlarged spleen using only laparoscopic instruments is difficult, prolongs the procedure, and conversion to open surgery is required in as many as 25% of these cases. In this situation HALS has proved to be particularly useful (Table 3).25,81 Litwin et al demonstrated the feasibility and utility of HALS in a multicenter, noncomparative series of 8 cases of splenomegaly without conversion and with a short hospital stay. Hellman et al also obtained good results (1 of 7 needed conversion, with a mean operative time of 133 minutes) in a series of 7 patients with massive splenomegaly approached by HALS (spleen weight ranging...
between 3.5 and 3.8 kg). In our experience, HALS reduced the duration of the procedure by 30% and the need for conversion to 8%, and had a clear impact on outcome.

Today, it is our preferred technique for splenectomy in cases of splenomegaly. An extremely interesting result of our experience with HALS is that general morbidity is lower and the hospital stay shorter than with conventional LS. This means that operative injury during HALS may well be lower than during LS and that the potential advantages of the laparoscopic approach are maintained despite the more intense intra-abdominal manipulation. Most indications for LS in cases of splenomegaly are hematological malignancies, with a deteriorated general state. In an earlier multivariate analysis of factors related to complications after LS, we showed that malignancy and splenomegaly correlated significantly with the occurrence of complications. The reduction in operative injury is likely to be associated with a quicker, safer recovery, and with fewer pulmonary and infectious complications.

From the technical viewpoint, the main advantage of HALS is the smoother retraction and exposition of the lower pole. The procedure also allows precise localization of the splenic artery, which can be tied, and the mobilization of the posterior face of the spleen. The hands bluntly dissect the pancreatic tail and facilitate the exact and careful placement of the (Endostapler) (Figure 4). Finally, the spleen can be easily extracted intact or morcellated through the 7-cm incision. Ren et al have reported the satisfactory performance of LS for a ruptured spleen using a HALS technique.

**Nephrectomy**

Hand-assisted laparoscopic surgery may also be particularly useful for nephrectomy. The most widely accepted urological indication for HALS is living-donor nephrectomy. Compared with open surgery, HALS living-donor nephrectomy is minimally invasive, warm ischemic time is shorter than when using a pure laparoscopic approach, and donor recovery is more comfortable, as the immediate and long-term viability of the kidney are main-

**Vascular Surgery**

Hand-assisted laparoscopic surgery has been applied in a range of vascular pathologic conditions. Promising results have been reported for aortobifemoral bypasses and in the treatment of aneurysms of the abdominal aorta.

**Gynecology**

The advantages of HALS have also been described in selected cases of gynecologic surgery (ie, megalimia, complex hysterectomies, or malignant pelvic lesions [ovary or endometrium]), despite the fact that there are no comparative studies.

**CONCLUSIONS**

Hand-assisted laparoscopic surgery may be an interesting alternative to conventional LS or open surgery. It simplifies the performance of difficult procedures for experienced surgeons and can initiate less experienced surgeons in advanced LS. Comparative trials with well-established laparoscopic techniques are required to define the absolute advantages of HALS. However, it may well be a useful resource before conversion to open surgery now that it has been demonstrated that it maintains the advantages of LS.

Accepted for publication October 5, 2002.

This study was supported by grant 01/173 from the Fondo Investigaciones Sanitarias, Barcelona.

Corresponding author: Eduardo M. Targarona, MD, PhD, Surgery Service, Hospital de la Santa Creu i Sant Pau, C/ Padre Claret 167, 08025 Barcelona, Spain (e-mail: etargarona@hsp.santpau.es).

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ne of the most useful contributions to the literature, which helps the surgeon at the grassroots level, is a review of an emerging or controversial topic. The authors of this article did not disappoint. Their thorough review of the literature on HALS was excellent. The article helps to put into perspective the proposed clinical applicability of what I call “bridging technology devices.”

Probably the most credible reason to embrace these appliances is that they may help to prevent the conversion of a laparoscopic to an open procedure. However, a 7-cm incision, suggested in the manuscript as being necessary to use the device, is suspect at best. Many surgeons would need a larger incision. With this in mind, some would argue that an open procedure using standard equipment could be performed without added expense.

The proposal that this device could serve as an intermediate step toward the total laparoscopic approach is much more difficult to justify. Without putting forth an organized and sustained educational effort to acquire superior targeting and 2-hand choreography skills, 2-dimensional depth perception compensation, and intracorporeal suturing, this device will “rest in peace” in an ever-increasing “technology graveyard,” populated with other appliances that have fallen short of the mark.

Other factors that need to be considered when evaluating the potential contribution of this appliance include cost and the possibility of skewing data on procedural effectiveness and quality of life. For example, it has been established in several publications that the cost of minimally invasive colon surgery is more expensive. Unfortunately, conversion is associated with a higher operative cost. The hand-assisted appliance adds additional financial burden to a procedure struggling to project fiscal responsibility. In addition, the skewing of outcomes in procedural effectiveness and quality of life may become a byproduct of widespread use of this class of products. This concern may become a reality if the HALS procedures are lumped in with minimally invasive colon procedures that do not use a less traumatic and morbid umbilical incision as the “primary extraction point” for specimen retrieval and extracorporeal anastomosis portal. Reports in the literature that fall into this “trap” may present data that show the overall morbidity signature for the technique as being more similar to the open procedure, therefore drawing erroneously into question the benefit of many minimally invasive surgical approaches.

I am also frustrated by sluggishly advancing minimally invasive surgical procedural adoption rates. Safe expansion of adoption rates must, however, be achieved by “standing on the shoulders of giants,” those surgical pioneers that have come before us to establish sound, reproducible principles based on skill, tactics, and technique rather than technology.

James C. Rosser, Jr, MD
New York, NY