ORIGINAL ARTICLE

# Laparoscopic Cholecystectomy and Common Bile Duct Exploration Using Choledochotomy and Primary Closure Following Failed Endoscopic Retrograde Cholangiopancreatography: A Multicentric Comparative Study Using Three-port vs Multiport

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## Abstract

**Background:** Laparoscopic surgery has changed many ways in which we as surgeons manage patients, offering better results, quicker recovery, and fewer complications using minimally invasive techniques, especially in common bile duct (CBD) surgery. Not only can laparoscopic techniques be applied to programed surgery but also emergencies and those following failed endoscopic retrograde cholangiopancreatography (ERCP).

**Objectives and aims:** Describe and compare clinical and surgical results of the laparoscopic CBD exploration with primary closure using a 3-port vs multiport approach.

**Materials and methods:** We present a multicentric comparative study of 197 consecutive patients who underwent a laparoscopic gallbladder removal along with CBD exploration with primary closure following failed (ERCP to extract CBD stones; 104 patients were managed by three-port vs 93 multiport laparoscopic surgery in five centers of Bogotá, Colombia, between 2013 and 2017 with follow-up of 1 year.

**Results:** A total of 197 patients were taken to laparoscopic gallbladder removal along with CBD exploration with primary closure, 104 patients via three-port technique and 93 patients via multiport. All (100%) the patients had previously failed ERCP. The average surgical time on the three-port approach was 106 minutes vs 123 minutes on multiport. Only in the multiport technique we had an average conversion of 2%. Mean hospital stay of 2.5 days, less for the three-port approach vs multiport in 5–7 days. There was a need of reintervention in 1% of the patients who underwent three-port exploration.

**Conclusion:** Postoperative pain, use of an additional port, complication rates, operation time, and cost of the three-port technique were similar to those of the conventional approach. Large randomized controlled trials are needed to examine the true benefits of the three-port technique.

**Keywords:** Common bile duct stones, Laparoscopic cholecystectomy, Laparoscopic common bile duct exploration.

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## Introduction

Laparoscopic cholecystectomy (LC) is seen as a gateway to minimally invasive surgery since the first operation was performed in 1987 and reported in 1996.[1] After this stimulating event, various modifications of LC have been developed year by year, including three-port, two-port, and single-port LC.[2] In the era of laparoscopic surgery, the treatment of benign common bile duct (CBD) diseases remains a topic of interest due to its surgical complexity.[3–5] Most CBD interventions are done with open surgery or endoscopically secondary to gallstone obstruction. With advances in surgical technique and instrumentation, CBD exploration using laparoscopy has emerged as an attractive alternative offering a safe and cost-effective option for CBD surgery[6–9] even in the emergency setting and following failed endoscopic treatment.[10,11] This series describes this three-port surgical technique for CBD exploration and primary closure as an alternative to conventional laparoscopy techniques for this surgery.

## Materials and Methods

We performed a multicentric retrospective, descriptive, and comparative study of laparoscopic common bile duct exploration

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(LCBDE) by choledochotomy and primary duct closure using the three-port technique vs the conventional laparoscopic approach (CLA) between January 2013 and December 2017 in five centers of Bogota, Colombia. There were 197 consecutive patients with failed endoscopic retrograde cholangiopancreatography (ERCP) in gallbladder and CBD stones. The choice of the use of three ports or the conventional technique was decided by the surgeon based on their expertise, skills, and intraoperative findings. Data from 104 patients with failed ERCP who underwent novel three-port approach were compared with 93 patients of the conventional multiport laparoscopic approach. The evaluated variables were demographic, clinical, intraoperative, and postoperative outcomes (Table 1).

Data were retrospectively collected and entered in the Excel database. These included demographic information, patient medical history (with particular attention to any biliary pathology), symptoms and form of presentation, age, sex, obstructive jaundice, American Society of Anesthesiologists (ASA) physical status classification system (ASAPS), surgery time, bleeding, bile leaks, complications, number of CBD stones removed, use of the T tube, conversion rates to laparotomy, oral feeding time, intensive care unit (ICU) admission, hospital stay time, the need for reintervention, postoperative strictures, stone recurrence, and mortality.

Follow-up data included hospital readmissions, diagnosis of residual stones, or new CBD procedures. Patient follow-up was carried out in the outpatient clinic for the first year, after which all data available in the patient medical records were reviewed; visits to the emergency or gastroenterology departments or any procedure for biliary disorders were investigated.

All patients had preoperative hepatobiliary ultrasound as first diagnosis image, then underwent to magnetic resonance cholangiopancreatography (MRCP) to confirm the diagnosis; Patients who had a CBD stone confirmation and failed ERCP were deemed candidates for a surgical CBD stone removal.

Patient consent for laparoscopic surgery and research was obtained before the procedure was started. The study protocol was approved by our institution's ethics committee. The protocol was implemented in accordance with provisions of the Declaration of Helsinki and Good Clinical Practice guidelines. Two of the surgical centers, where the three-port technique was used, had hepatobiliary surgeons with more than 5-year experience on laparoscopic surgery; in the other three centers, the management was performed by laparoscopic general surgeons. This material was presented at SAGES meeting, Baltimore, 2019 (Abstract id 94039).

**Table 1:** Comparative sociodemographic variables, between three-port and conventional laparoscopic approach (CLA)

| *Variables* | *Three-port (n = 104)* | *CLA = 93* |
|---|---|---|
| Sociodemographic characteristics | | |
| Age (years) (min–max) | 47 (47–91) | 52 (52–59) |
| Sex | | |
| Male (%) | 72 | 66 |
| Female (%) | 28 | 34 |
| Patients with comorbidities (%) | 32 | 27 |
| Obese patients (*n*) | | |
| BMI > 30 | 17 | 6 |
| ASAPS | | |
| I (%) | 35 | 59 |
| II (%) | 48 | 31 |
| III (%) | 17 | 10 |
| Obstructive jaundice (%) | 86 | 98 |
| Bile duct caliber (mm) | 11 (10–13) | 13 (10–15) |

## Indications

### Inclusion Criteria

Our series involves patients over 18 years of age with CBD stones taken to cholecystectomy, choledochotomy, and CBD primary closure by the laparoscopic technique following failed ERCP.

### Exclusion Criteria

Patients with CBD diameter <6 mm, acute cholangitis, severe acute biliary pancreatitis, previous history of cholecystectomy, CBD malignancy, severe adhesive bowel syndrome due to prior open procedures, and those unwilling or unfit to undergo laparoscopic surgery were excluded.

## Surgical Technique

### Patient Preparation

All the patients were prepared for LC and CBD exploration using choledochotomy and primary closure just as they would be for an open operation. Patients and their families were informed of the surgical risks, the possible need for additional trocars, conversion to open surgery, and mortality.

### Equipment and Room Set-up

Under general anesthesia, the patient was placed in the supine position with both arms tucked along their sides and pneumatic stocking, also with the legs spread wide open. The patients were securely strapped to the surgical bed to facilitate maximum tilting and lateral rotation of the surgical table. All patients received prophylactic antibiotics according to the latest clinical practice WHO guidelines for prevention of surgical site infection (SSI). All of the procedures were performed in the French position, the first surgical assistant stood at the surgeon's right and the second assistant to the left. The scrub nurse stood to the right of the first surgical assistant.

### Laparoscopic Cholecystectomy and CBD Exploration Using Choledochotomy and Primary Closure by Three-port Technique

Under general anesthesia, an open Hasson's technique was made for the placement of a 12-mm umbilical port and creation of pneumoperitoneum applying a 14 mm Hg intra-abdominal pressure to allow the insertion of a 30° laparoscope. Two additional ports were placed under direct vision, a 5-mm port in the right flank and a 12-mm port in the left paramedial area (Fig. 1).

Using a single Prolene 2-0 (Ethicon, Inc., Cincinnati, OH, USA) suture, the gallbladder was elevated from the fundus and held against the abdominal wall in the right upper quadrant in order to expose Calot's triangle (Fig. 2). Using a laparoscopic dissector and hook, the triangle of Calot was dissected revealing the critical view. Once the porta hepatis and the inferior hepatic surface were exposed, dissection of the common hepatic and CBD was performed taking care not to devascularize the CBD.

A vertical anterior 10–20 mm choledochotomy was performed. The CBD stones were directly extracted using a laparoscopic dissector followed by proximal and distal bile duct lavage with a Nelaton tube size 16–20 fr. and 20–50 cc of normal saline solution until clear fluid returned (Fig. 3). The last step of the proximal and

distal CBD exploration was done using a Fogarty catheter size 6–8 fr. (Figs 4 and 5).

Primary CBD closure was done using laparoscopic simple interrupted PDS 4-0 (Ethicon, Inc., Cincinnati, OH, USA) sutures. Intraoperative cholangiography through the cystic duct stump was performed to evaluate residual CBD stones (Fig. 6).

The gallbladder portion of the surgery was completed by clipping the cystic artery and duct using titanium clips—3× total clips for each structure. Laparoscopic cholecystectomy was performed using a cystic-fundus technique with a hook. The fundus-abdominal wall suture is cut and using an endo-catch the gallbladder was extracted through the left paramedial port site. The abdominal cavity was drained and checked for bleeding; an active peritoneal drain was placed in the CBD zone. Trocars were extracted under direct vision, pneumoperitoneum was evacuated, and the abdominal wall was closed using simple interrupted PDS 0 (Ethicon, Inc., Cincinnati, OH, USA) sutures and the skin was sutured using Prolene 3-0 (Ethicon, Inc., Cincinnati, OH, USA).

### Postoperative Care

The patient ambulated the same day of the procedure and tolerated oral food intake. The abdominal drain was removed at postoperative day 2, and the patient was discharged during the following day among their hemodynamic status improve.

### Discharge and Follow-up

Patients were discharged once the peritoneal drain was removed. Follow-up assessment using ultrasound and the liver function test was carried out for 3–24 months after discharge in the outpatient clinic if the patient had jaundice or abdominal pain. If either studies revealed abnormalities for possible residual stones, MRCP or ERCP was carried out to investigate further biliary compromise.

## Statistical Analysis

The analysis of data was performed using Microsoft Excel databases and analyzed using the SPSS1 (Statistical Package for the Social Sciences) 22.0 version. Variables continuous were treated by means (range). Variables were summarized using median, minimum, maximum values, and percentages.

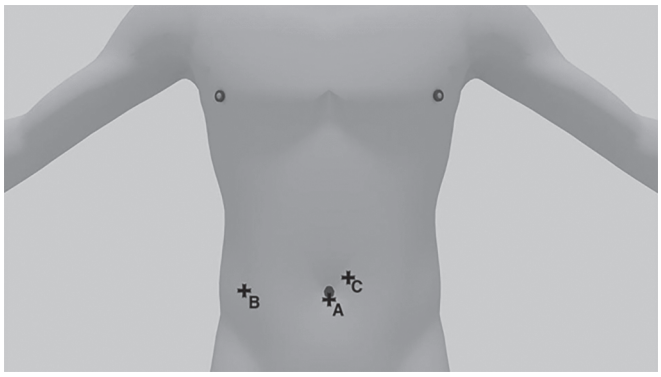


**Fig. 1:** Trocars position

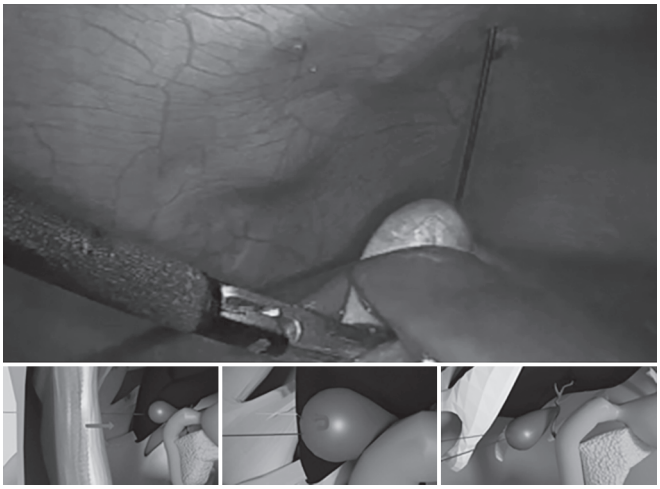

**Fig. 2:** Gallbladder suspension for exposed Calot's triangle

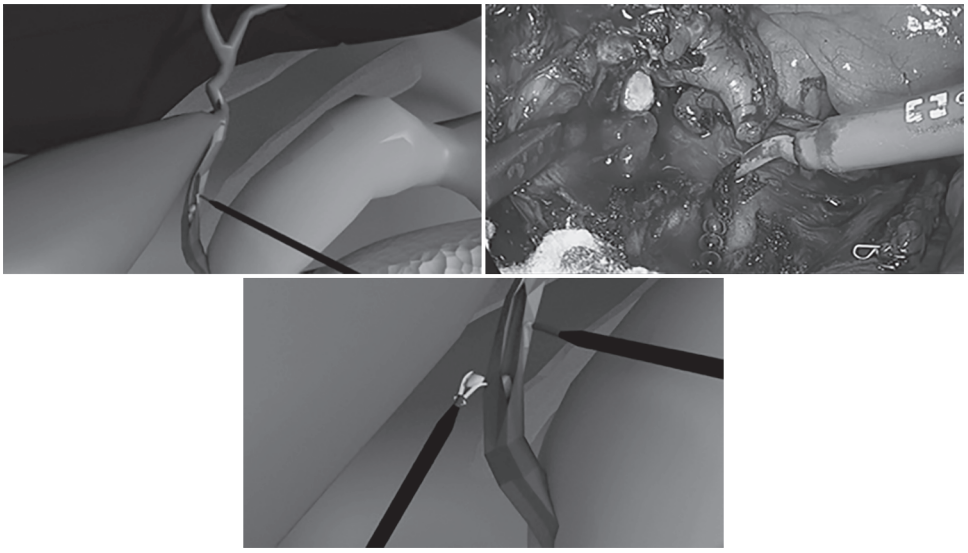

**Fig. 3:** Choledochotomy

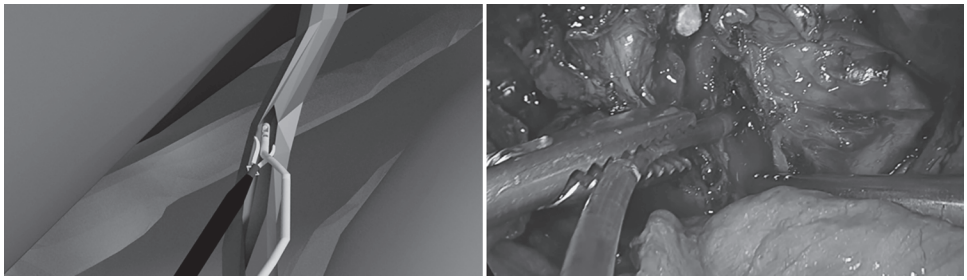

**Fig. 4:** Distal bile duct lavage with a Nelaton tube

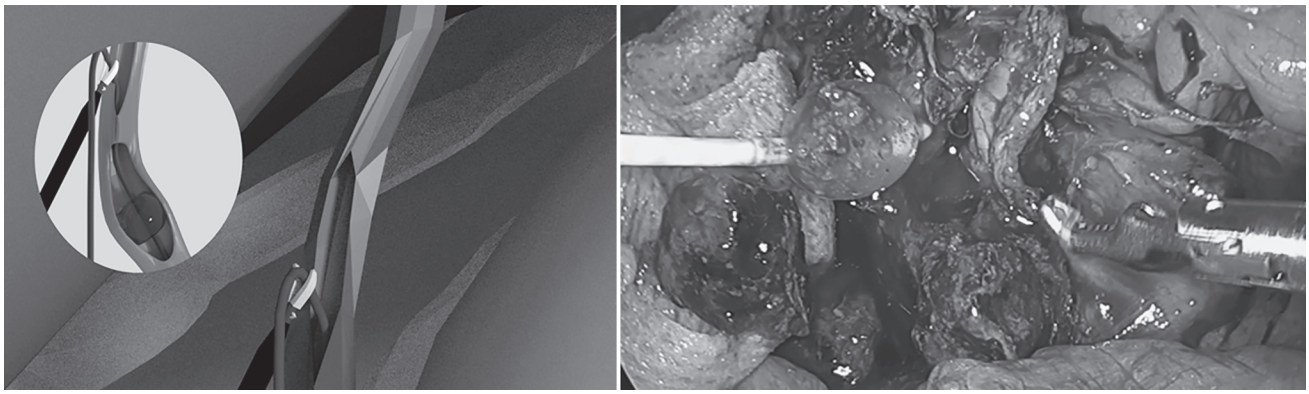

**Fig. 5:** The common bile duct exploration using a Fogarty catheter

## Results

### Patient Characteristics

There were 104 patients taken to three-port vs 93 CLA who underwent to CBD exploration with primary closure and cholecystectomy following failed ERCP for CBD stones. The distribution of the matching variables in two groups is shown in Table 1.

Previous abdominal surgery history was obtained in patients in both groups. The majority of operations were Caesarean section. Gynecologic operations (hysterectomy, myomectomy, and oophorectomy) and appendectomies followed in the descending order. No upper abdominal operations were seen in both groups.

After all the data were collected, we compared operation time, conversion rates, length of hospital stay, and postoperative complications between two groups. Difference of postoperative results between two groups was shown in Table 2.

There were no preoperative conversion to open surgery in both groups and no laparoscopic salvage (conversion to four-port or more) needed.

### Outcome Definitions and Follow-up

Operative time was defined as the interval between the initial skin incision and skin closure. Postoperative hospital stay was defined as the number of days spent in the hospital postoperatively. In-hospital mortality and morbidity were defined as the number of deaths or complications that occurred in hospital. About 2% of patients had postoperative bile leaks treated with ERCP and plastic stent. About 1% of patients had a recidivated CBD stone at 24 months following the procedure and were taken to a new CBD exploration using conventional laparoscopy. There were no mortalities, hospital stay averaged 3 days, and 2% patients required ICU admission for 2–3 days; as a result of the decompensation of their comorbidities, the follow-up time was in a range of 6 months to 5 years and no late complications were documented as stricture (Table 3).

## Discussion

To our knowledge, this is the first comparative series of patients taken to a three-port laparoscopic vs multiport CBD exploration, primary closure, and cholecystectomy for CBD stones following failed ERCP. Our goal was to perform a single intervention with less trauma to patients with similar results to traditional laparoscopic approaches reported in the literature avoiding two separate interventions increasing risks to patients.[12–14] The ERCP still offers the best initial approach to CBD stone treatment; however, in cases when extraction is not possible, a single intervention in expert hands may decrease risks and hospital stay to patients.[4] When deemed necessary, a hepatobiliary resonance image was ordered. This series shows a success rate above 99.04%, above those reported by Gigot et al. (74%), one of the first series of laparoscopic CBD surgery.[15] Recent reports show similar success rates such as Salama et al. (95%), highlighting the safety of advanced laparoscopic app roaches.[9,10,16–18]

Our mean CBD diameter was 11 mm, comparable to a study by Chander et al.[19] where the average diameter was 11.7 mm and Topal et al.[18] where the average diameter was 11.5 mm, but Wani et al.[20] and Khan et al.[21] studies showed the mean CBD diameter of 15 mm. Conversion was not needed, similar to no conversions in Bandyopadhyay et al.[22] study to 4% in others.[23,24] The reasons for conversion in their studies were learning curve, dense adhesions, bleeding, technical difficulties, impacted stones, and so on. We started feeding like the study by Bandyopadhyay et al.[22] were started orally on the day of surgery and were ambulatory next day with a mean hospital stay similar of 6.76 $\pm$ 1.33 days ranging from 5 to 11 days.

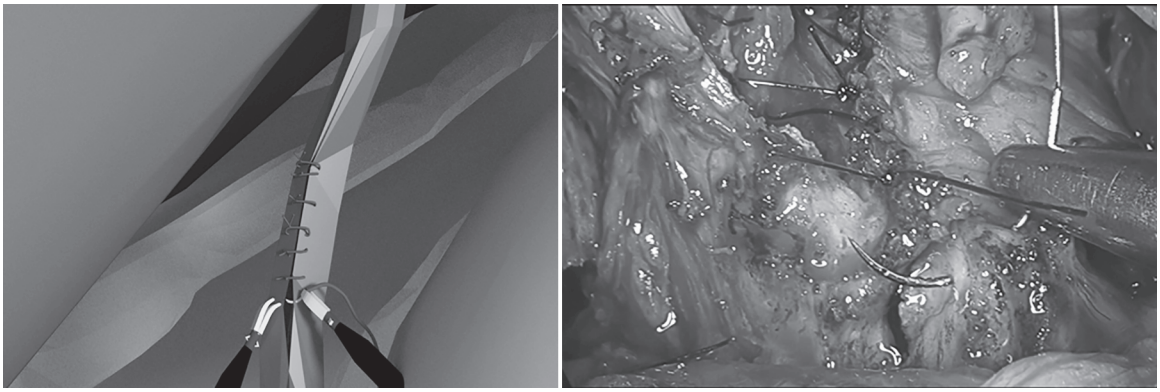

**Fig. 6:** Primary closure of common bile duct

**Table 2:** Comparative surgical characteristics, between three-port and conventional laparoscopic approach (CLA)

| *Surgical characteristics* | | |
|---|---|---|
| *Variables* | *Three-port (n = 104)* | *CLA = 93* |
| Surgical time (minutes) | 106 (100–130) | 123 (115–142) |
| Number of CBD stones removed | 2.8 (2–4) | 3 (2–5) |
| Operative bleeding (mL) | 50 | 50 |
| Conversion to open procedure (%) | 0 | 2 |

**Table 3:** Comparative outcomes and complications, between three-port vs conventional laparoscopic approach (CLA)

| *Variables* | *Three-port, n = 104* | *CLA = 93* |
|---|---|---|
| Outcomes and complications | | |
| T tube (%) | 0 | 0 |
| Reintervention (%) | 0 | 0 |
| SSI (%) | | |
| Superficial SSI | 0 | 1.5 |
| Bile leak (*n*) | 1 | 3 |
| Need for CBD reexploration (*n*) | 1 | 0 |
| Non per os (days) | 1 | 1 |
| ICU (days) | 1–2 | 1–2 |
| Hospital stay (days) | 2–5 | 5–7 |
| Mortality | 0 | 0 |
| Postoperative strictures | 0 | 0 |
| Stone recurrence (%) | 2 | 2 |
| Maximum follow-up (year) | 1 | 1 |

SSI, surgical site infection; CBD, common bile duct

Among novelties in this series, we highlight the use of a single procedure to explore the CBD, primary closure avoiding the traditional use of a T tube and cholecystectomy with a three-port technique with similar results to traditional laparoscopic techniques without any variations in intraoperative bleeding or complications. Podda and colleagues reported a meta-analysis including 1,770 patients describing the advantages and superiority of primary CBD closure vs T tube[25,26] and other authors like Platt et al. reported no differences using a laparoscopic approach in elderly patients in comparison to younger patients following choledochotomy and primary closure like in our study.[27] Additionally, a single surgery offers clear advantages to patients allowing for a quicker return to daily activities, fewer days in the hospital, less costs, and fewer complications.[28] Bile duct leak remains a significant topic and although surgeon experience and CBD diameter directly influence this risk, age is not a risk factor and, in our series, just one patient presented bile leak similar to Zhou et al.[29]

Another advantage of laparoscopic CBD exploration is the preservation of the Oddi´sphincter and avoiding complications secondary to endoscopic manipulation such as stenosis and future stone formation.[25] Although there are no significant differences using a three-port approach vs traditional laparoscopy for this procedure, it seems to be a safe and effective method with similar results and less trauma to patients and esthetically superior. It is important to highlight that adding another port or converting to open surgery should not be considered a surgical failure.[30–32] Success rates with three-port LC reaches 90% in most series; in this series success rate was 100%, allowing a more rapid return to daily activities averaging 1–2 days or fewer days in the hospital.[33] This single three-port laparoscopic approach shows results similar to those involving traditional ERCP followed by laparoscopic gallbladder removal done using two separate procedures. The choice of approach depends on patient status, surgeon experience, and equipment availability.[34,35]

## Limitations

The main limitation of this study is that it is an observational retrospective study without randomization.

## Conclusion

A laparoscopic three-port approach to LCBDE surgery is a high complex minimally invasive surgery that in expert hands can be a safe and cost-effective alternative for CBD stones; nevertheless, a conventional approach seems to have same results. Both types of approach could be "reproducible" and depends on the ergonomic and decision of the surgeons, their expertise, skills, and intraoperative findings. Success rates match those of endoscopy, other laparoscopic techniques, and open surgery with less trauma to the patient and fewer complications.

## Compliance with Ethics Guidelines

Daniel Gomez, Luis F Cabrera, Ricardo Villarreal, Mauricio Pedraza, Jean Pulido, Sebastián Sánchez, Cristina Jimenez, and Andres Mendoza have no conflicts of interest or financial ties to disclose.

This article has the ethical approval by all the institutional review boards and ethics committees.

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