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Robot-assisted laparoscopic common bile duct exploration: Case report and proposed training model

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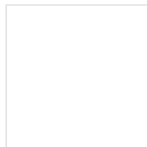
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Abstract and Figures

We present a case of a 32-year-old female patient with the diagnosis of gallstone disease and choledocholithiasis. Prior to in vivo surgery, we practiced the critical steps of the procedure using a proposed inert training model. We performed a robot-assisted laparoscopic common bile duct exploration, obtaining one stone. The operating time was 140min (console time: 120min) with no complications during the procedure. The patient was discharged 2days after the operation. Robot-assisted minimally invasive surgery of the common bile duct is a safe and effective procedure and seems to have some benefits over conventional laparoscopic surgery. KeywordsCholedocholithiasis–Robotic surgery–Laparoscopy–Training



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J Robotic Surg
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CASE REPORT

Robot-assisted laparoscopic common bile duct exploration: case report and proposed training model

Alexis Sánchez · Omaira Rodríguez ·
Hugo Davila · Rair Valero · Gustavo Benítez ·
Renata Sánchez · Maria F. Visconti

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Abstract We present a case of a 32-year-old female patient with the diagnosis of gallstone disease and choledocholithiasis. Prior to in vivo surgery, we practiced the critical steps of the procedure using a proposed inert training model. We performed a robot-assisted laparoscopic common bile duct exploration, obtaining one stone. The operating time was 140 min (console time: 120 min) with no complications during the procedure. The patient was discharged 2 days after the operation. Robot-assisted minimally invasive surgery of the common bile duct is a safe and effective procedure and seems to have some benefits over conventional laparoscopic surgery.

Keywords Choledocholithiasis · Robotic surgery · Laparoscopy · Training

Introduction

The incidence of choledocholithiasis in patients with gallstone disease varies between 9 and 16%. Clinical and paraclinical evidence is absent in 5% of patients, and for this reason evaluation of the biliary duct is essential to establish the management of this pathology [1].

There are many options for managing choledocholithiasis: laparoscopic or open common bile duct

exploration, intraoperative or postoperative endoscopic retrograde cholangiopancreatography (ERCP) and antero grade sphincterotomy.

Laparoscopic common bile duct exploration (LCBDE) has been demonstrated to be a safe and effective procedure that has the advantages of minimally invasive surgery [1–4]. There is evidence which indicates that laparoscopic surgery has an important role in the resolution of choledocholithiasis. Several strong-evidence studies conclude that LCBDE is as effective as ERCP in the treatment of choledocholithiasis, with some advantages such as shorter length of hospital stay and lower costs [3, 4].

The next logical step in modern common bile duct surgery is to introduce robotic surgery for the treatment of this pathology. The first published report of a robot-assisted common bile duct exploration appeared in 2003; however to date there are few reports of this procedure [5, 6].

The efficacy and safety of every surgical procedure using new technologies are directly proportional to the surgical team's training and expertise. In this paper we show a proposed inert, low-cost, readily available training model, which allows surgeons to practice critical steps in robot-assisted common bile duct surgery for resolution of choledocholithiasis.

The main objective of this publication is to report our initial experience in robot-assisted LCBDE in the robotic surgery program at the University Hospital of Caracas, Venezuela.


Patient and methods

Training model

The model we propose is simple, low-cost, and readily available, allowing the surgeon to simulate the fundamental steps of robot-assisted common bile duct surgery

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sions the surgical team performed four tasks (Fig. 1).

Task A: Supraduodenal choledochotomy and lateral stitch position and traction using the third robotic arm.

Task B: Stone capture and extraction using the choledochoscope.

Task C: "T" tube placement.

Task D: Choledochotomy closure.

Performing these steps gives us the chance to practice the necessary skills that will facilitate adequate accomplishment of the surgery, which is considered technically very demanding.

Case report

Abdominal ultrasound in a 32-year-old female patient with a meal-related upper right quadrant abdominal pain demonstrated gallstones and dilatation of the common bile duct (10.8-mm). Laboratory tests showed mild elevation

one stone in the distal common bile duct. She was admitted with the diagnosis of gallstone disease and choledocholithiasis. We scheduled robot-assisted LCBDL surgery.

Surgical technique

The surgical procedure was performed with the patient in the supine position. Five operating ports were used: a 12-mm camera port infra-umbilical, then, using direct vision, we used two 8-mm da Vinci ports for arms 1 and 2 in epigastric and right lumbar regions, respectively. We also used a 12-mm port for choledochoscopy and a 5-mm port for retracting (Fig. 2).

The robot system was docked over the right shoulder of the patient (Fig. 2); then, after identifying Calot's triangle the cystic duct and cystic artery were dissected. A longitudinal supraduodenal choledochotomy was performed. We introduced the choledochoscope and identified on

Fig. 1 Robot-assisted common bile duct exploration training model

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Fig. 2 Robotic system placement in the operating room and position of trocars. *O* optic, 1 and 2 robotic arms, *A* assistant, *C* choledochoscope

Fig. 3 Identification of common bile duct stone under direct vision of choledochoscope

stone of 1 cm in the distal common bile duct; it was extracted with a nitilon basket (Figs. 3, 4).

We then performed proximal and distal inspection with no evidence of secondary biliary calculi. Finally, we performed primary closure of common bile duct using separate stitches with vycril 4.0.

Finally, we performed the cholecystectomy and placed a subhepatic drainage. The operating time was 140 min (console time: 120 min) with no complications during the procedure. The length of stay was 48 h. The patient was discharged in good condition.

Discussion

Since the introduction of laparoscopic cholecystectomy in 1987 and its acceptance as the treatment of choice for this

Fig. 4 Extraction of common bile duct stone captured with nitilon basket

pathology, the remarkable progress achieved in technological areas allows us to advance to the next level in minimally invasive biliary surgery. The first laparoscopic exploration of the common bile duct was reported in 1991 since then, multiple studies have shown high levels of success and low comorbidity [1–4].

There is evidence which indicates that laparoscopic surgery on the biliary tract for patients with choledocholithiasis can be used as the first-line treatment. Cuschier et al. reported that laparoscopic cholecystectomy and laparoscopic exploration of common bile duct (one-step procedure) is even effective when compared with two-step treatment (ERCP and posteriorly laparoscopic cholecystectomy). It has similar comorbidity and the advantage of shorter length of hospitalization [3]. The National Institute of Health (NIH) consensus statement reported in the year 2002 that laparoscopic surgery has the same effectiveness as ERCP [7].

Although it is true that minimally invasive surgery has advantages over conventional surgery, there are also some disadvantages that at present cannot be improved, such as two-dimensional vision, depth loss, lack of degrees of freedom of the instruments, and disparity between visual feedback and proprioceptive function (the fulcrum effect) [8].

Developing technology and the incorporation of robot-assisted surgery can improve many limitations of laparoscopic surgery; in addition to the availability of three-dimensional vision, increase in the degrees of freedom, avoiding the *fulcrum* effect and optimizing ergonomics, this technology also offers other advantages: it eliminates surgeon tremor and it gives a stable picture and personal camera control, and more comfort for the surgeon which reduces the physical and mental stress [9].

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The role of robot-assisted surgery continues to improve in specialties like urology and gynecology, where it has been increased the incidence of radical prostatectomies and radical hysterectomies [10, 11]. The adoption of robotics in general surgery has been a slower process, due to the nature of abdominal surgery. However, the next few years are likely to show an improvement in minimally invasive robotic surgery due to the clinical benefits described previously [12].

The incorporation of robot-assisted surgery is the next logical step for the treatment of choledocholithiasis. Roegen published the first report of choledochotomy robot-assisted

At the present we are carrying out a protocol to compare robot-assisted laparoscopic common bile duct exploration with conventional laparoscopy.

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We started our robot-assisted laparoscopic surgery experience 8 months ago. The training sessions on our proposed model allow us to develop the necessary skills for the procedure, contributing to its safety and efficacy. Further studies are directed towards objectively determining the impact of the model on skills acquisition.

Surgical skills training and evaluation using inert models is a useful tool in surgical education in preclinical settings [13]. Several studies have demonstrated that after practicing laparoscopic surgery on an inert model like the one proposed and mastering certain steps *ex vivo*, adequate transfer of training occurs within the operating room, thus reducing failures and complications as well as advancing the learning curve [14]. We have previously demonstrated our experience using such models in advanced laparoscopic surgery training [15].

The main advantage of the Da Vinci system, besides optimal vision, is the EndoWrist instruments which enhance dexterity for precision and control beyond the capabilities of the human hand, allowing a better dissection of the biliary tract, choledochotomy and optimal manipulation of choledochoscopy, which facilitates the exploration. Robotic surgery appears to decrease the length of the procedure, even if we have to add the docking phase of the robot. In our case the surgery time was 2 h, similar time to our conventional laparoscopic surgery experience.

The role of robotic surgery in the treatment of choledocholithiasis is still to be decided. There are few reports at this time, and this case is the first report in Latin America. We do not hesitate to recommend this procedure as the best choice for selective patients in centers with access to this technology.

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... In patients in whom ERCP is ineffective, the laparoscopic conversion rate increases mainly because of impacted stones that require complex management. 2 The incorporation of new technologies such as robotic surgery and a holmium laser in the management of choledocholithiasis increases the success rate, allowing proper handling of complex cases. 3, 4 Robot-assisted surgery helps to overcome difficulties of other minimally invasive approaches, providing a 3-dimensional view and high maneuverability of the instruments. The holmium laser allows fragmentation of large impacted stones and their subsequent removal using conventional methods such as balloons or helicoid baskets. ...

... LCBDE was performed according to the technique described by Sánchez et al. 4 The patient was placed in the supine position. Five operating ports were used: An infraumbilical 12-mm camera port was placed first, followed by placement of two 8-mm ports for arms 1 and 2, as shown in Figure 2. We also used a 12-mm port for the choledochoscope and a 5-mm port for retraction. ...

... Roeyen et al, 8 in 2004, reported the first robot-assisted common bile duct exploration in the literature; we published our initial experience in 2010. 4 To date, there have been few reports and short series regarding this procedure. 3,4,9 The EndoWrist instrument (Intuitive Surgical, Sunnyvale, California) enhances the dexterity of the surgeon, improving precision and control beyond the human hand's capabilities, in addition to allowing a better dissection of the biliary tract, as well as choledochotomy, and an optimal manipulation of the choledochoscope, which facilitates the exploration. ...

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Mar 2015

Alexis Sanchez · Omaira Rodríguez · Renata Sanchez · Jose Rosciano

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... (22,23) Convencidos de la gran utilidad de los modelos inanimados los autores han descrito y validado modelos de entrenamiento en apendicectomía laparoscópica (Figura 3A), (24,25) modelos de entrenamiento para la exploración laparoscópica de la vía biliar (Figura 3B); (26,27) el impacto de este último modelo en los resultados de la cirugía fue reportado en el año 2011, así mismo, se describió su incorporación al entrenamiento en cirugía robótica asistida con el Sistema DaVinci®. (28, 29) Los modelos animales o cadáveres permiten la práctica de procedimientos completos, obteniendo una óptima retroalimentación propioceptiva al trabajar con tejidos reales, así como el control adecuado de la homeostasia en los modelos animales. Sin embargo, son modelos costosos, que requieren de ambientes especializados y cumplir con regulaciones legales. ...

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... Strömberg et al. suggested that stones exceeding 5 mm in size have a much lower likelihood of TC extraction and are susceptible to impaction [9]. As such, a variety of methods have been reported for improving extraction rate via the TC route including robotic techniques [10], micropercutaneous nephrolithotomy [11], electrohydraulic lithotripsy (EHL) [8,12] and, more recently, holmium laser lithotripsy [13]. The use of holmium laser treatment is already well established in urological surgery, including its use in ureteric stones, enucleation of the prostate, strictures and bladder tumours [14]. ...

Holmium laser lithotripsy improves the rate of successful transcystic laparoscopic common bile duct exploration[Article](#) [Full-text available](#)

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Laparoscopic surgery for choledocholithiasis concomitant with calculus of the left intrahepatic duct...

November 2017 · Surgical Endoscopy

● Yueqi Wang · Xiaobo Bo · Yaojie Wang · [...] · ● Houbao Liu

Background: Laparoscopic common bile duct exploration (LCBDE) has been widely promoted in recent years as a safe and effective treatment for choledocholithiasis. However, there are no standard guidelines for the treatment of patients who have concomitant hepatolithiasis of the left liver and abdominal adhesions. The aim of the current research was to compare the outcomes of open versus ... [\[Show full abstract\]](#)

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Laparoscopic common bile duct exploration in patients with previous upper abdominal surgery

December 2018 · Surgical Endoscopy

Jisheng Zhu · Gen Sun · Le Hong · [...] · ● Weidong Xiao

Background: Although patients with previous upper abdominal surgery are no longer considered as a contraindication in laparoscopic surgery, laparoscopic common bile duct exploration (LCBDE) for these patients is still controversial. The aim of this study was to evaluate the safety and effectiveness of LCBDE for patients with previous upper abdominal surgery. Methods: Two hundred and seventeen ... [\[Show full abstract\]](#)

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An Alternative Approach of Choledocholithotomy via Laparoscopic Choledochotomy

May 1996 · Archives of Surgery

S M Huang · ● Chia-Yu Wu · Gar-Yang Chau · [...] · F K P'eng

To evaluate the safety and feasibility of laparoscopic choledocholithotomy via choledochotomy for the treatment of choledocholithiasis. A prospective series of 1332 consecutive patients who underwent laparoscopic cholecystectomies, with a mean follow-up of 21.2 months. University-affiliated referral center. Patients: Forty-three patients (3%) with documented common bile duct stones from January ... [\[Show full abstract\]](#)

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Entrenamiento en cirugía robótica: Propuesta de un modelo de entrenamiento para la cirugía laparoscópica...

January 2010

H. Davila · ● Omaira Rodríguez · Maria F. Visconti · [...] · ● Alexis Sanchez

New technologies have promoted the development of minimally invasive surgery. The recently introduced robotic technology seems to be a great advance in laparoscopic surgery. This system has some advantages in optical systems and degrees of freedom of the arms. However, the efficacy and safety of surgical procedures is determined by the training of the surgical team. In this paper we show a ... [\[Show full abstract\]](#)

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Robotic surgery: A proposal for a training program in laparoscopic surgery of the main bile duct usi...

January 2010

H. Davila · ● Omaira Rodríguez · Maria F. Visconti · [...] · ● Alexis Sanchez

New technologies have promoted the development of minimally invasive surgery. The recently introduced robotic technology seems to be a great advance in laparoscopic surgery. This system has some advantages in optical systems and degrees of freedom of the arms. However, the efficacy and safety of surgical procedures is determined by the training of the surgical team. In this paper we show

[Download full-text PDF](#)[Download citation](#)[Copy link](#)Article [Full-text available](#)**Laparoscopic Common Bile Duct Exploration Four-Task Training Model: Construct Validity**

August 2012 · JSL: Journal of the Society of Laparoendoscopic Surgeons / Society of Laparoendoscopic Surgeons

● Alexis Sanchez · ● Omaira Rodríguez · ● Natalia Otaño · [...] · ● Michael Schweitzer

Training models in laparoscopic surgery allow the surgical team to practice procedures in a safe environment. We have proposed the use of a 4-task, low-cost inert model to practice critical steps of laparoscopic common bile duct exploration. The performance of 3 groups with different levels of expertise in laparoscopic surgery, novices (A), intermediates (B), and experts (C), was evaluated using ... [\[Show full abstract\]](#)

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June 2009

● Omaira Rodríguez · ● Renata Sanchez · Gustavo Benítez · ● Alexis Sanchez

In order to compare the success of the laparoscopic exploration in patient with complicated choledocholithiasis versus single stage laparoscopic management, we realized a prospective study of 20 patients with indication of laparoscopic common bile duct exploration admitted in the period February 2005 - October 2008. We studied patients in whom the PCRE was ineffective versus single stage ... [\[Show full abstract\]](#)

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