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CASE REPORT

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

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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: laporoscopic or open common bile duct exploration, intraoperative or postoperative endoscopic retrograde cholangiopancreatography (ERCP) and anterograde 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 surgeries

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for resolution of choledocholithiasis. In the practice sessions 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 of hepatic enzymes and endoscopic ultrasound revealed one stone in the distal common bile duct. She was admitted with the diagnosis of gallstone disease and choledocholithiasis. We scheduled robot-assisted LCBDE 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 one

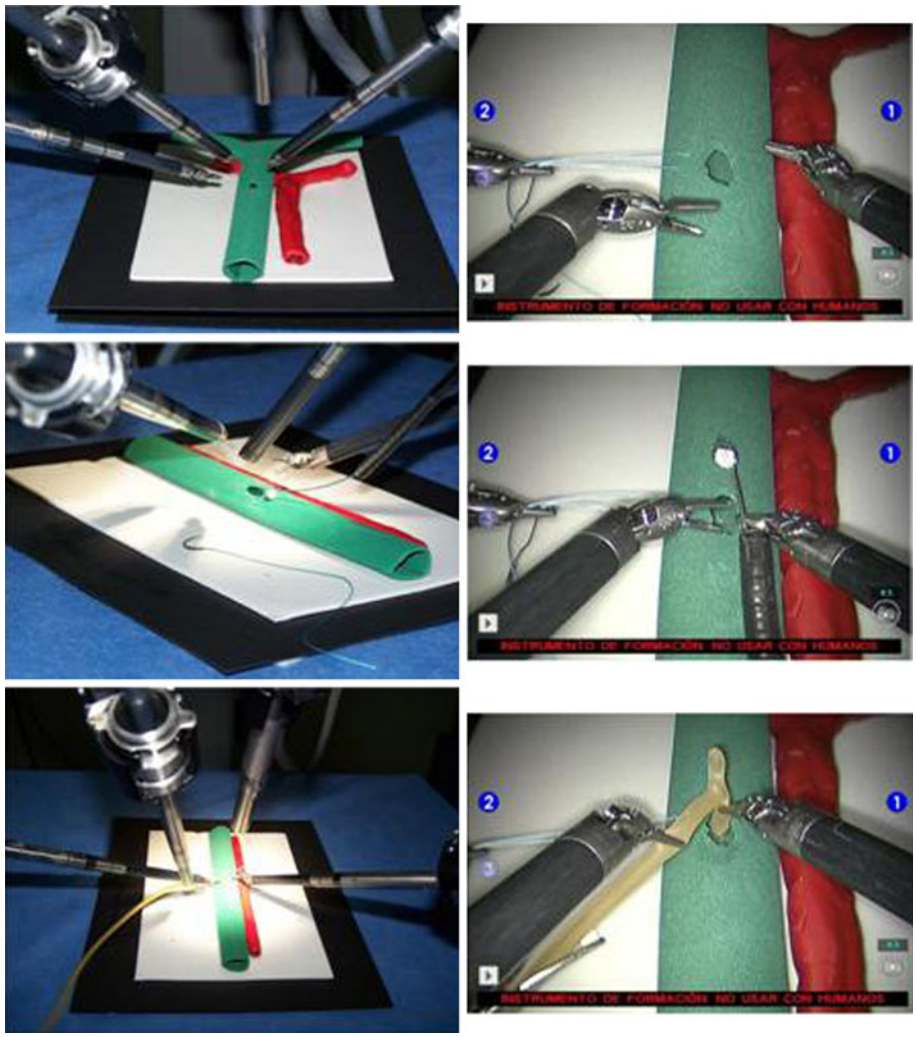

Fig. 1 Robot-assisted common bile duct exploration training model

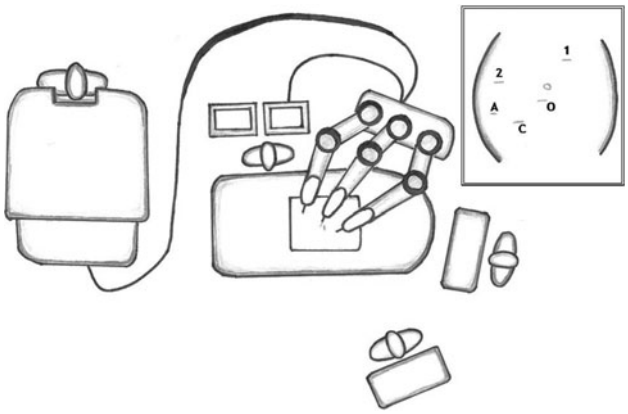

Fig. 2 Robotic system placement in the operating room and position of trocars. *O* optic, 1 and *2* robotic arms, *A* assistant, *C* choledochoscope

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

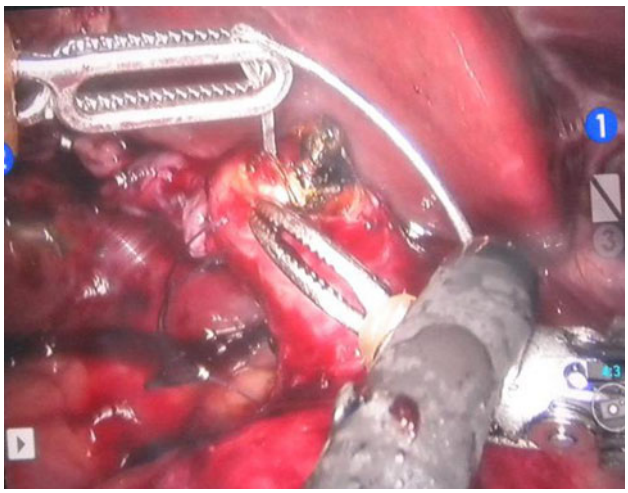

Fig. 4 Extraction of common bile duct stone captured with nitilon basket

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. Cuschieri 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 Institutes 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].

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 in 2003, but world-wide there have been very few reports of this technique [5, 6].

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, choledocotomy 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.

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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