Masters Program Biliary Pathway: Multiport Robotic Cholecystectomy

2

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Introduction

Surgical management of gallbladder disease changed drastically with the advent of laparoscopic techniques in the 1990s. Initially, laparoscopic techniques were cumbersome due to the new orientation and lack of direct contact with tissues [1, 2]. This technology rapidly evolved with improved instrumentation and optics to become the standard approach for cholecystectomy [3, 4]. The course of robotic surgery began with the implementation of a camera steadying system to assist laparoscopic surgery. The field continued to advance with improved instrumentation to include fully wristed instruments with seven degrees of motion, 3D vision, fluorescently enhanced optics, and even remote access [5].

Multi-Port Robotic Cholecystectomy (MPRC) has been shown to be as safe as the laparoscopic approach with similar operative times and hospital lengths of stay [6, 7]. Breitenstein et al. compared laparoscopic cholecystectomies (LC) to MPRC and found similar outcomes between the two approaches [7]. Another study showed a decrease in robotic docking time from 12.1 to 4.9 min after the initial learning curve [8]. If studies with more than 50 cases are analyzed the average docking times for MPRC ranged from 4.3 to 17 min and average total operative time was 52.4–95.7 min [6–10] (Table 2.1). MPRC offers improved visualization and fully wristed instruments, but has not been widely adopted, likely due to the need for larger ports, robotic availability, and robotic docking time. In our experience, MPRC may still have an advantage in re-operative fields, obese patients, and when no surgical assistant is available.

MPRC also allows a safe and reliable method of training future surgeons and the learning curve is shorter than traditional laparoscopic surgery [8, 9]. This chapter

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Table 2.1 Multi-port robotic cholecystectomy outcomes

	N	Robotic docking time (min)	Console time (min)	Total time (min)	Major complication (bile leak, bleeding)
Vidovszky et al. (2006)[a]					
MPRC	51	4.9	32.5	68.2	None
Breitenstein et al. (2008)					
LC	50	–	–	50.2	2%
MPRC	50	17	30	54.6	2%
Kim et al. (2013)					
MPRC	178	4.3	15.1	52.4	0.6%
Ayloo et al. (2014)					
LC	147	NA	NA	89.6	2.0%
MPRC	179	NA	NA	95.7	1.7%

Data from PubMed search for SIRC with greater than 50 patients
SIRC single incision robotic cholecystectomy, *LC* conventional laparoscopic cholecystectomy, *MPRC* multi-port robotic cholecystectomy, *NA* not available
[a]After the initial learning curve

focuses on the safe application of robotic technology to biliary disease. The most commonly used robotic system is the da Vinci Si Surgical System (Intuitive Surgical Inc. Sunnyvale, CA). Although other platforms exist in various stages of development, our chapter will focus on the use of the da Vinci Si system. Many of the concepts will be broadly applicable to other systems.

Indications

The indications for MPRC are similar to those of traditional laparoscopic cholecystectomy. These include symptomatic cholelithiasis, cholecystitis, acalculous cholecystitis, symptomatic gallbladder polyps or polyps greater than 10 mm, porcelain gallbladder, and biliary dyskinesia [11].

Equipment and Operating Room Team Development

The three components of the da Vinci Surgical System are the Surgeon Console (SC), Vision Cart (VC) and Patient-side Cart (PSC). The SC is positioned away from the operative field and controls the instrumentation and visualization of the operative field. The VC is also positioned away from the operative field and contains supporting hardware and software, such as the optical light source, electrosurgical unit, and optical integration. The PSC is the only component docked within the operative field and is covered with sterile drapes. It has four articulated mechanical arms that control the instruments that are docked to the ports.

The efficient use of any system requires the coordination of all personnel involved. At our institution, we have achieved very efficient robotic docking times

with organization and training of operating room personnel. Our structure consists of a robotic nurse manager, equipment specialist, circulating nurse, and scrub nurse. This structure is not limited to robotic cases but applies to any specialty cases. The robotic nursing supervisor specifically overseas all robotic cases to ensure the appropriate personnel and equipment are assigned to the room several days in advance. The equipment specialists are responsible for setup and troubleshooting of all laparoscopic and robotic equipment across multiple rooms. In our robotic rooms, they are responsible for the location of all robotic components and positioning of robotic equipment during the operation. The circulating nurse is responsible for additional equipment used during the operation. The scrub nurse is responsible for instrument exchange at the patient's bedside. Using this system, we achieved an average docking time of 5 min [8, 12].

Patient Positioning and Peritoneal Entry

The patient is placed supine on the operating room table. After intubation, the elbows should be properly padded and secured in the adducted position. The bed is angled 45° with the head moving to the patient's right. The right arm is tucked, so the PSC can eventually be positioned over the patient's right shoulder. The scrub nurse and sterile instrument table are generally positioned near the foot of the bed. The SC is placed away from the operating room table. The VC can be positioned to the left or right, away from the sterile field (Fig. 2.1).

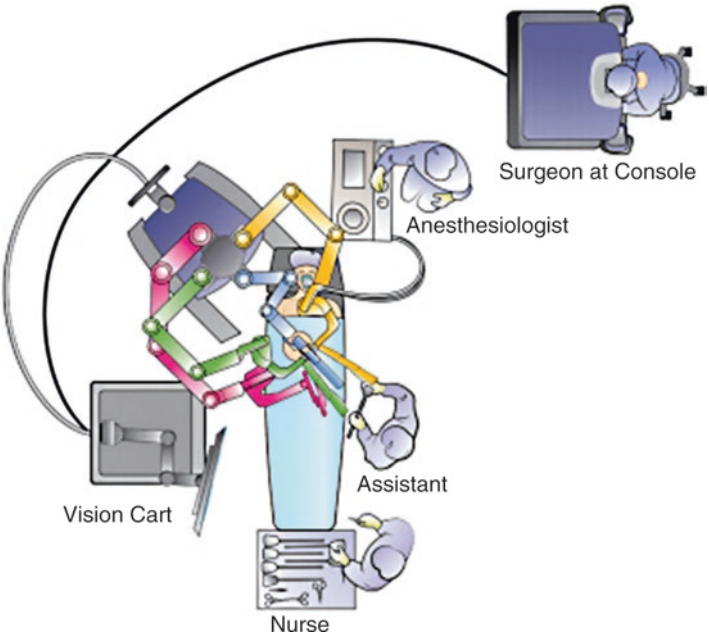

Fig. 2.1 Robotic equipment position during multi-port cholecystectomy

Access can be gained with a periumbilical incision to maintain at least a 15 cm distance from the camera to the operative field in the right upper quadrant. If there are no previous incisions in the area, we elevate the fascia and use either an open technique or veress needle in order to obtain pneumoperitoneum, followed by a 12 mm optical entry port. After peritoneal access is gained, the abdominal cavity is inspected through the periumbilical port. It can be helpful to use an extra-long 12 mm port because this allows adequate length for robotic docking independent of the patient's body habitus. Next, two separate 8 mm robotic ports are placed in the right upper quadrant, 8–10 cm away from one another. These robotic ports are best placed in line with one another and slightly cephalad to the camera port, positioning one along the mid-clavicular line and one along the anterior axillary line. Finally, an 8 mm robotic port is placed in the left upper abdomen. This is ideally placed in the midclavicular line and slightly more cephalad than the right sided abdominal ports (Fig. 2.2).

Technical Pearls

- Placing the endotracheal tube to the left can avoid collision with the robotic arms.
- A footboard should be used to avoid inadvertent movement of the patient intraoperatively. Padding and taping of the ankles helps to avoid rolling of the foot during positioning.
- Care should be taken to place the left upper quadrant port so that a line between the port and gallbladder does not bisect the falciform ligament.
- In patients with prior abdominal incisions, we prefer a direct-access Hasson technique for abdominal access or left upper quadrant optical entry.
- In patients with a large distance between the umbilicus and right subcostal margin, a supraumbilical incision may be of greater benefit.

Fig. 2.2 Port placement for multi-port robotic cholecystectomy (1): 8 mm robotic port for hook electrocautery. (2): 8 mm robotic port for infundibular grasper. (3): 8 mm robotic port for fundal grasper. Camera port: 12 mm extra-long port. Assistant: optional port placement

Robotic Dissection

The patient is next placed in a reverse Trendelenburg position with a slight left lateral rotation. The sterile covered PSC subsystem is positioned over the right humeral area of the patient. The middle boom should be in line with the gallbladder and camera port.

The camera is initially docked. A 30° downward facing scope allows for excellent visualization after proper downward calibration and white-balancing. Following this, the 8 mm ports are docked. The ports should be docked to avoid collision with one another, with special care given to ensure that the camera arm is at its "sweet-spot," indicated by the blue line, once docked.

Under direct visualization, we place two graspers in the right upper abdominal ports and a hook cautery into the left upper quadrant port. The gallbladder is grasped in a manner similar to the laparoscopic approach. The lateral port is used for cephalad retraction on the fundus, while the medial port manipulates the infundibulum. We begin our dissection using the hook cautery on the gallbladder near the area of the cystic artery. The artery is traced down to open the peritoneum over the cystic duct/gallbladder junction. Next, the peritoneum is separated both lateral and medial to the gallbladder. We will carefully dissect within Calot's triangle until a critical view is obtained (Fig. 2.3).

We place medium sized hemo-o-lok clips on either side of the cystic duct and cystic artery prior to transection with robotic shears. Finally, the gallbladder is dissected off the liver with hook cautery. A 5 mm assistant port can be placed in either the right upper quadrant or between the camera port and left sided abdominal port if additional assistance is needed.

The lateral grasper is removed, and a laparoscopic grasper is inserted and placed on the gallbladder infundibulum. All remaining instruments and the camera are removed. The PSC is undocked and removed from the operative field, and the patient is placed in the level position. If the 10 mm camera was used, then a 5 mm laparoscopic camera is inserted into the remaining 8 mm right upper quadrant port. Under direct visualization, a laparoscopic retrieval bag is used through the 12 mm

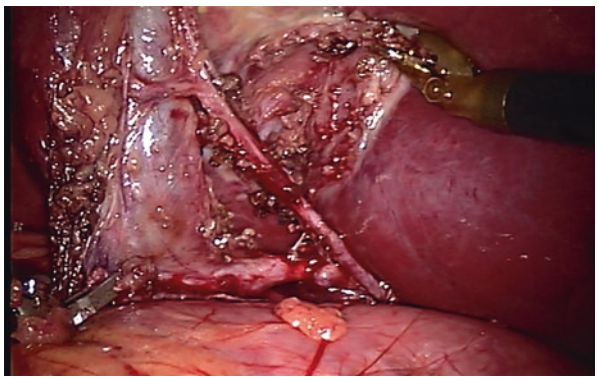

Fig. 2.3 Critical view of a Calot's triangle (picture from the University of California, Davis Department of Surgery archive)

port to secure the gallbladder and remove it. If an 8 mm robotic camera was used, then it can be controlled manually through the 8 mm port. It is unnecessary to have the standard laparoscopic camera. The fascia of the 12 mm port is approximated and pneumoperitoneum is released. All sites are closed with absorbable suture and sterile dressing.

Technical Pearls

- A 30° downward facing scope may offer more visual advantages when dissecting the cystic duct and artery. The robotic camera must be calibrated for upward or downward direction. We recommend always calibrating for both directions.
- Use of an 8 mm robotic camera obviates the need for standard laparoscopic instruments.
- Avoiding collision of robotic arms is paramount intra-operatively. This can be accomplished by adjusting the right lateral port to swing as wide as possible. The remaining ports should have a minimum of 8 cm between all joints.
- A higher grasping strength instrument may be better for retracting the fundus.
- Visual haptics are important with right lower quadrant retraction of the infundibulum because excessive retraction may cause injuries.
- If a cholangiogram needs to be performed, the table can remain in position. The C-arm can be brought into position from the left side after undocking and repositioning the PSC.

Conclusion

Studies on MPRC have demonstrated its safety for treatment of a variety of gallbladder diseases. MPRC provides a safe and reliable method for cholecystectomy. The advantages of wristed instruments and improved visualization over standard laparoscopy have yet to be determined, but will likely have the most significant advantage in reoperative fields, obese patients, and when a surgical assistant is unavailable. It also allows for an optimal teaching platform of basic and advanced minimally invasive technique. The most important aspect of the application of new technology is strict adherence to the standard principles of good surgical technique.

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