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Detecting performance variance in complex surgical procedures: analysis of a step-wise technique for laparoscopic right hepatectomy

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Variance;
Manufacturing productivity tools

Abstract

BACKGROUND: Laparoscopic right hepatectomy (LRH) is a technically challenging operation. Our aim is to evaluate a standardized technique of LRH and determine variances in performance.

METHODS: The procedure was deconstructed into 7 major step-wise components. All LRH followed the same surgical sequence, and used the same devices and operating room set-up. Thirty randomly selected video recordings of the procedure underwent intraoperative time analysis. The variances measured by standard deviation of each step were calculated (mean in minutes ± standard deviation).

RESULTS: Mean total operative time was 114 ± 25 min. The steps with the least variance were inferior vena cava dissection (8 ± 3) and right hepatic vein ligation (9 ± 5). The longest and also the step with the greatest variance was parenchymal transection (35 ± 12).

CONCLUSIONS: LRH can be performed consistently using a standardized step-wise technique. Parenchymal transection had most variation, and this could be explained by intrinsic liver factors. Surgical performance improvement should begin with deconstructing the operation into definable steps to identify areas for change.

Major liver resections along with pancreaticoduodenectomies and gastric bypasses are probably the most complex abdominal surgical procedures. Because of the demands of vascular inflow and outflow occlusion, laparoscopic right hepatectomy (LRH) remains a challenging procedure even for experienced hepatobiliary surgeons. We have performed more than 50 LRH using a standardized approach with a reproducible step-wise technique, forming the basis for this operational assessment.

Some have advocated that surgical procedures can be improved by the standardization of operative technique and uniformity of practice.[1] With the increased complexity of the operation, there is a real challenge to generate a

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standardized protocol because of the multiplicity of steps and devices required. This problem is further confounded by surgeon-to-surgeon variations in approaching the same operation. To overcome these hurdles in standardizing complex operations, we believed that it is possible to borrow concepts from manufacturing practices where entire operations and processes are deconstructed into component steps.[2,3]

We used the setting of an LRH, which is a complex abdominal operation. We believed that a step-wise approach makes any operation reproducible and teachable, and will provide the basis for standardization and future comparison. The aim of this study is to deconstruct our technique of LRH into critical steps, perform an intraoperative time analysis, determine variances in performance, and identify potential areas of improvement.

Methods

This is an observational prospective study. We performed several cases initially and then had a consensus meeting for technique standardization. The operation was broken down into 7 critical steps (right hepatic artery ligation, right portal vein ligation, right hepatic lobe mobilization, retrohepatic inferior vena cava (IVC) dissection, right hepatic vein (RHV) ligation, parenchymal transection, hemostasis/bile leak check) that were agreed upon by 2 surgeons (J.M.S., E.L.). All the procedures followed the same surgical steps with the same instruments and OR protocol. This standardized approach was done by combining the expertise of a hepatobiliary and a minimally invasive surgeon. A senior general surgery resident or a fellow participated in every single operation.

All patients underwent preoperative imaging. We prefer to have a magnetic resonance imaging for inflow and outflow evaluation before surgery. Some patients needed intraoperative ultrasound to better localize the tumor and its relationship with major vascular structures.

Instruments, ports, and positioning

The operation uses three 12-mm trocars, one 5-mm trocar, and a Hand port (Gelport) for retraction and specimen retrieval. We also use a 30° laparoscope, basic laparoscopic instruments, 5 mm advanced bipolar device (LigaSure; Covidien), ultrasonic scalpel (Harmonic; Ethicon), vascular staplers, and topical hemostatic agent (FloSeal; Baxter International Inc). The patient is placed in the supine position with the operating surgeon standing at the left side and the assisting surgeon standing at the right side (Fig. 1). The table is tilted 30° reverse Trendelenburg and 30° to the left later during the operation.

Step 1: right hepatic artery ligation

First, we perform the right hepatic artery dissection using cautery and fine dissectors that are commonly used for cholecystectomy. We typically take the cystic duct and artery, and leave the gallbladder in situ for retraction. The artery is ligated with 2-0 silk and transected with the advanced bipolar device.

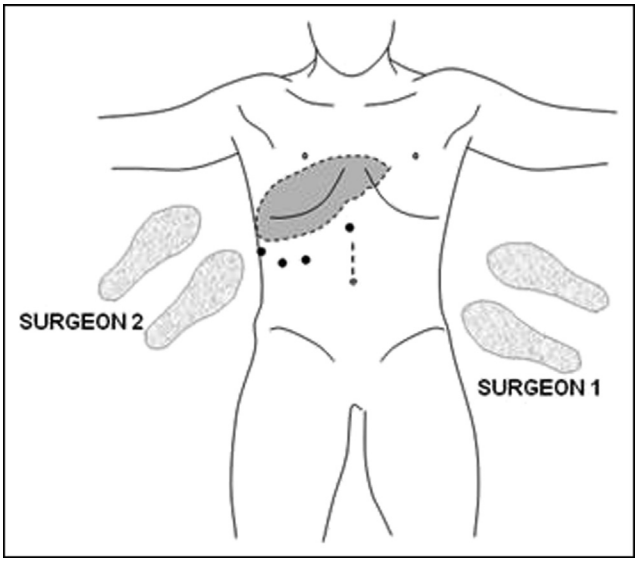

Figure 1 The diagram shows the surgeon and assistant surgeon positions during the operation. Three 12-mm trocars (2 in the right upper quadrant and 1 in the epigastrium), one 5-mm trocar (right upper quadrant), and a Hand port (upper midline) are needed.

Step 2: right portal vein ligation

The portal vein is exposed using similar atraumatic graspers and an angled dissector. The right portal vein is surrounded by a 2-0 silk suture for manipulation, and a vascular stapler is used to transect it (Fig. 2). In some circumstances when we cannot apply the stapler to the vein because of reduced space or limited angulation, large clips are applied to occlude the vascular inflow.

Step 3: right hepatic lobe mobilization

In this step, the liver is separated from the retroperitoneal and diaphragm attachments using cautery scissors and blunt dissection. The surgeon's hand is especially useful during this stage for lifting the liver and facilitating the exposure of retroperitoneal structures, especially over the bare area of the liver.

Step 4: inferior vena cava dissection

The retrohepatic IVC is separated from the liver using the advanced bipolar device, and if a right inferior hepatic vein is encountered, vascular staplers are used to divide it. We advance this dissection all the way up to the IVC ligament.