Ann Surg Oncol
https://doi.org/10.1245/s10434-019-07474-w

Annals of
SURGICAL ONCOLOGY
OFFICIAL JOURNAL OF THE SOCIETY OF SURGICAL ONCOLOGY

ORIGINAL ARTICLE – HEPATOBILIARY TUMORS

Robotic Left Hepatectomy and Roux-en-Y Hepaticojejunostomy After Bile Duct Injury

Marcel Autran Machado, MD, FACS[1,2], Rodrigo C. Surjan, MD[1,2], Andre O. Ardengh[2], and Fabio Makdissi, MD[2,3]

[1]Department of Surgery, University of São Paulo, São Paulo, Brazil; [2]Nove de Julho Hospital, São Paulo, Brazil; [3]Department of Gastroenterology, University of São Paulo, São Paulo, Brazil

ABSTRACT

Background. Bile duct injuries after cholecystectomy remain a major concern because their incidence has not changed through the years despite technical advances. This video presents a robotic left hepatectomy and Roux-en-Y hepaticojejunostomy as a treatment for a complex bile duct injury after laparoscopic cholecystectomy.

Methods. A 52-year-old man underwent laparoscopic cholecystectomy at another institution 8 years previously, which resulted in a bile duct injury. His postoperative period was complicated by jaundice and cholangitis. He was treated with endoscopic retrograde cholangiopancreatography and multiple endoprostheses for 3 years, after which the endoprostheses were removed, and he was sent to the authors' institution. Computed tomography showed that the left liver had signs of disturbed perfusion and dilation of the left intrahepatic bile duct. The patient was asymptomatic and refused any further attempt at surgical correction of the lesion. He was accompanied for 5 years. Magnetic resonance imaging showed progressive atrophy of the left liver. Finally, 3 months before this writing, he presented with intermittent episodes of cholangitis. A multidisciplinary team decided to perform left hepatectomy with Roux-en-Y hepatojejunostomy via a robotic approach. The left liver was atrophied, and left hepatectomy was performed. Fluorescence imaging was used to identify the right bile duct. At opening of the right bile duct, small stones were found and removed. Antecolic Roux-en-Y hepaticojejunostomy then was performed.

Results. The operative time was 335 min. Recovery was uneventful, and the patient was discharged on postoperative day 4.

Conclusions. Robotic repair of bile duct injuries is feasible and safe, even when liver resection is necessary. This video may help oncologic surgeons to perform this complex procedure.

Bile duct injury (BDI) after cholecystectomy remains a major concern because its incidence has not changed through the years despite technical advances.[1] Complex injury, including vascular damage, may require liver resection and can be a definitive treatment.[2]

In a worldwide review, 99 hepatectomies were reported among 1756 (5.6%) patients referred for post-cholecystectomy bile duct injury.[3] None of these hepatectomies was performed by a robotic or minimally invasive approach. This video aims to present a robotic left hepatectomy and Roux-en-Y hepaticojejunostomy as treatment for a complex BDI after laparoscopic cholecystectomy.

METHODS

A 52-year-old man underwent laparoscopic cholecystectomy in another institution 8 years previously. During the operation, massive bleeding occurred, which resulted in inadvertent injury of the bile duct confluence. The operation was converted, the bile duct was sutured, and hemostasis was achieved.

The patient's postoperative period was complicated by jaundice and cholangitis. He underwent interventional endoscopy with endoscopic retrograde cholangiopancreatography

Electronic supplementary material The online version of this article (https://doi.org/10.1245/s10434-019-07474-w) contains supplementary material, which is available to authorized users.

First Received: 3 March 2019

M. A. Machado, MD, FACS
e-mail: dr@drmarcel.com.br

Published online: 30 May 2019

(ERCP) and insertion of multiple and bilateral endoprostheses. His treatment during the next 3 years involved regular changing and/or repositioning of the endoprostheses. After this period, the endoprostheses were removed, and the patient was referred to our institution.

Cholangiography showed areas of partial stenosis without significant dilation of the intrahepatic bile ducts. Liver function test results remained abnormal. Computed tomography (CT) scanning showed that the left liver had signs of disturbed perfusion and dilation of the left intrahepatic bile duct. The patient was asymptomatic and refused any further attempt to correct the injury with surgery. He then was followed up for 5 years. Magnetic resonance imaging (MRI) showed progressive atrophy of the left liver.

Finally, 3 months before this writing, he started to present with intermittent episodes of cholangitis. An MRI showed complete atrophy of the left liver, dilation of the left bile duct, and areas of stenosis in the biliary confluence (Fig. 1a–c).

A multidisciplinary team decided to perform surgical correction. A left hepatectomy with Roux-en-Y hepatojejunostomy was indicated. A robotic approach was proposed, and consent was obtained from the patient. This study was approved by the review board of the Department of Surgery at our institution.

Surgical Technique

Patient Positioning and Port Placement The patient was placed supine in 30° reverse Trendelenburg position. Robotic surgery was performed with the da Vinci Xi robotic platform (Intuitive Surgical Inc., Sunnyvale, CA, USA). This technique used five trocars (Fig. 1d). Pneumoperitoneum was created with an open technique, due to a previous operation, in the supra-umbilical port (R3 in Fig. 1d). Pneumoperitoneum was established at 14 mmHg. The remaining trocars were inserted under direct vision.

Using this technique, the surgeon is seated at the robotic console, and the assistant surgeon stands on the patient's left side. The assistant surgeon performs retraction, suction, clipping, stapling, and changes of the robotic instruments.

Liver Mobilization After pneumoperitoneum creation, some adhesions were found. Before docking, some adhesions were divided with laparoscopic instruments to allow insertion of the remaining trocars. Once the abdomen was cleared, the robotic arms were docked for the robotic phase.

The left hemiliver (S2-S3-S4) was completely atrophied. The operation began with left liver mobilization. The falciform and left triangular ligaments were divided with scissors. The middle and left hepatic veins were dissected and identified. The left liver was firmly adhered to the stomach and carefully detached from the gastric wall. After opening of the lesser omentum, the caudate lobe was seen and seemed normal.

Hilar Dissection Adhesions to the hepatic hilum were divided, and the portal triad was progressively exposed. Fluorescent imaging highlighted the common bile duct and helped the surgical team to identify it correctly. The common bile duct then was dissected from the portal vein. The left hepatic artery, together with the segment 4 branch, was divided between hemolocks. The left portal vein was dissected and temporarily clamped. Fluorescent imaging showed no left liver perfusion. The left portal vein then was ligated and divided between hemolocks, and the proximal stump was immediately sutured with 4-0 polypropylene stitches.

Parenchymal Transection The future line of transection was marked with cautery along the ischemic line. The liver was divided with the use of bipolar forceps under continuous saline irrigation. The middle hepatic vein was encountered during liver transection and preserved. The left hepatic bile duct, found to be completely obstructed, was divided. Finally, the left hepatic vein was divided by stapling, and the left hepatectomy was completed.

Roux-en-Y Hepatojejunostomy Fluorescent imaging was used to identify the intrahepatic path of the right bile duct. The exact area of bile duct stenosis was identified and opened with scissors. The opening was enlarged. Small biliary stones were retrieved, and the bile duct was flushed with saline until normal bile flow resumed. This type of stone usually is encountered in chronic obstruction of the bile duct and does not warrant further investigation.

The next step was to perform the Roux-en-Y loop. The jejunum was divided with a stapler 30 cm from the Treitz angle. The Roux-en-Y loop was constructed with latero-lateral jejuno-jejunostomy using a stapler. The opening was closed in a two-layer running suture, and the jejunal loop was brought for hepatojejunostomy in antecolic fashion. Hepatojejunostomy was performed with 5-0 absorbable sutures. The raw liver area then was checked for bleeding and bile leakage. The abdominal cavity was drained, and the operation was completed with removal of the surgical specimen through the supraumbilical incision.

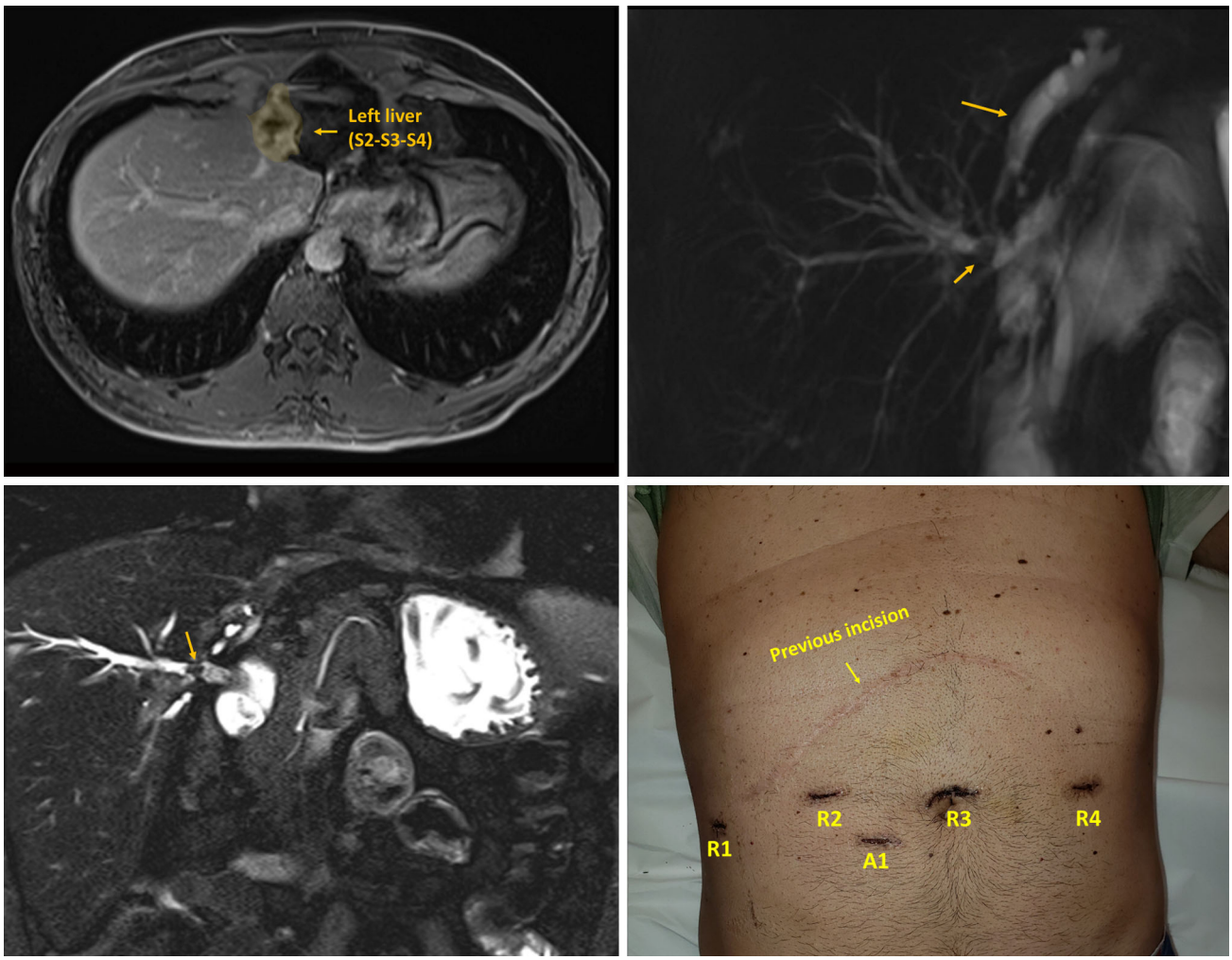

FIG. 1 Bile duct injury after cholecystectomy. **a** Magnetic resonance imaging (MRI, axial view) showing complete atrophy of the left hemiliver (segments 2–4). **b** MRI cholangiogram showing important dilation of the left bile duct (*large arrow*) and areas of stenosis/stones in the right duct (*small arrow*). **c** MRI (coronal view) showing stenosis/stones in the right duct (*small arrow*) with intrahepatic dilation. **d** Postoperative photograph of the abdominal wall showing previous incision, incisions for the robotic arms (R1–R4), and the auxiliary port (A1)

RESULTS

The operative time for docking was 6 min. Adhesiolysis required 46 min, and the robotic left hepatectomy was completed in 45 min. The operative time was 130 min for the hilar dissection and 108 min for the Roux-en-Y hepatojejunostomy. The Pringle maneuver was not necessary during the operation. The patient's estimated blood loss was 80 mL, with no need for intra- or postoperative transfusion.

The patient's recovery was uneventful, and he was discharged on postoperative day 4. The drain was removed on postoperative day 6. The surgical specimen (left hemiliver) weighed only 30 g. No malignancy was found in the specimen. At this writing, the patient is well and asymptomatic 6 months after the operation.

DISCUSSION

Minimally invasive repair of the bile duct still is a debated issue, with only a few cases reported in the English literature. Currently, most biliary injuries are repaired with an open operation because the conventional laparoscopic approach has some limitations, especially in confined spaces. However, the robotic approach, with its added degrees of freedom and stability of the robotic platform, may offer options for minimally invasive repair that can overcome these limitations. The da Vinci robot provides × 20 magnified three-dimensional vision, improving the precision of dissection in areas of dense adhesions and allowing anastomosis sutures at difficult angles with the non-dominant hand, when necessary.[4,5]

Although a matched comparison between robotic and laparoscopic hepatic resections showed no significant differences in operative outcomes, a greater proportion of more complex major hepatectomies are completed when the robotic approach is used.[6] Indeed, the reported case was unusually complex and technically demanding, making the robotic approach the ideal choice. However, the operative time was long, in part due to the presence of hard adhesions that required meticulous dissection of the hepatic hilum. The use of other robotic instruments such as a robotic stapler and a robotic hemolock applier may reduce operative time but increases operative costs.

The progressive atrophy of the left liver with vascular damage and proximal BDI seen in the reported patient was classified as a complex BDI. Although a minor BDI, such as leakage from the cystic duct or common bile duct, often can be managed endoscopically, surgical reconstruction frequently is needed for a major BDI.[3,7,8] In addition, our patient presented with intermittent episodes of cholangitis due to obstruction of the biliary tract with dilation of intrahepatic left bile duct. Aided by intraoperative fluorescent cholangiography with indocyanine green,[9] the bile duct was identified, and side-to-side hepatojejunostomy anastomosis could be performed with no major difficulties.[10] Using this technique, extensive and hazardous dissection of the bile duct can be avoided, thus preserving its blood supply and allowing wider anastomosis.[10,11]

Fluorescent cholangiography is useful and easy to perform. It can add important information about location of the bile duct, bile leakage, hepatico-jejunostomy leak testing, and liver perfusion.

The literature has few reports describing the use of robotic systems to repair iatrogenic biliary injuries, and none of them describe liver resection to complete this task.[12–14] The cases that required liver resection were considered too complex for minimally invasive approaches and often were treated using a conventional open approach.

In summary, the robotic approach was an important tool for completing this complex procedure with a totally minimally invasive approach. To the best of our knowledge, no other descriptions of a robotic left hepatectomy together with Roux-en-Y hepatojejunostomy for complex BDI exist in the English literature.

CONCLUSIONS

Robotic repair of BDI is feasible and safe, even when liver resection is required. This video may help oncologic surgeons to perform this complex procedure.

REFERENCES

1. Barrett M, Asbun HJ, Chien HL, et al. Bile duct injury and morbidity following cholecystectomy: a need for improvement. *Surg Endosc.* 2018;32:1683–8.
2. Pekolj J, Yanzón A, Dietrich A, et al. Major liver resection as definitive treatment in post-cholecystectomy common bile duct injuries. *World J Surg.* 2015;39:1216–23.
3. Truant S, Boleslawski E, Lebuffe G, et al. Hepatic resection for post-cholecystectomy bile duct injuries: a literature review. *HPB* (*Oxf*). 2010;12:334–41.
4. Ayloo S, Schwartzman J. Robot-assisted repair of E1 biliary ductal injury with Roux-en-Y hepaticojejunostomy. *J Laparoendosc Adv Surg Tech A.* 2018. https://doi.org/10.1089/lap.2018.0664.
5. Prasad A, De S, Mishra P, Tiwari A. Robotic assisted Roux-en-Y hepaticojejunostomy in a post-cholecystectomy type E2 bile duct injury. *World J Gastroenterol.* 2015;21:1703–6.
6. Tsung A, Geller DA, Sukato DC, et al. Robotic versus laparoscopic hepatectomy: a matched comparison. *Ann Surg.* 2014;259:549–55.
7. Schmidt SC, Settmacher U, Langrehr JM, Neuhaus P. Management and outcome of patients with combined bile duct and hepatic arterial injuries after laparoscopic cholecystectomy. *Surgery.* 2004;135:613–8.
8. Vitale GC, Tran TC, Davis BR, et al. Endoscopic management of postcholecystectomy bile duct strictures. *J Am Coll Surg.* 2008;206:918–23.
9. Maker AV, Kunda N. A technique to define extrahepatic biliary anatomy using robotic near-infrared fluorescent cholangiography. *J Gastrointest Surg.* 2017;21:1961–2.
10. Machado MC, da Cunha JE, Bacchella T. A modified technique for surgical repair of cicatricial stenosis of the bile duct. *Surg Gynecol Obstet.* 1986;162:282–4.
11. Winslow ER, Fialkowski EA, Linehan DC, et al. "Sideways": results of repair of biliary injuries using a policy of side-to-side hepatico-jejunostomy. *Ann Surg.* 2009;249:426–34.
12. Cuendis-Velázquez A, Bada-Yllán O, Trejo-Ávila M, et al. Robotic-assisted Roux-en-Y hepaticojejunostomy after bile duct injury. *Langenbecks Arch Surg.* 2018;403:53–9.
13. Cuendis-Velázquez A, Trejo-Ávila M, Bada-Yllán O, et al. A new era of bile duct repair: robotic-assisted versus laparoscopic hepaticojejunostomy. *J Gastrointest Surg.* 2019;23:451–9.
14. Giulianotti PC, Quadri P, Durgam S, Bianco FM. Reconstruction/repair of iatrogenic biliary injuries: is the robot offering a new option? Short clinical report. *Ann Surg.* 2018;267:e7–9.