Journal of Robotic Surgery (2023) 17:55–62
https://doi.org/10.1007/s11701-022-01392-y

ORIGINAL ARTICLE

Robotic biliary surgery for benign and malignant bile duct obstruction: a case series

Mathieu D'Hondt[1] · **Dennis A. Wicherts**[2]

Received: 19 January 2022 / Accepted: 18 February 2022 / Published online: 21 March 2022

Abstract

The majority of patients with benign or malignant biliary obstruction require surgical treatment with a bilio-enteric anastomosis. This requires fine dissection and advanced suturing. Robotic surgery may overcome some major limitations of conventional laparoscopic surgery. The precise role of robotic biliary surgery is, however, still to be defined. In our institution, patients requiring complex bile duct surgery were consecutively selected for minimally invasive robotic surgery from September 2020. All surgeries were undertaken using the da Vinci Xi Surgical System® (Intuitive Surgical, Sunnyvale, CA, USA). Intra-operative technique and postoperative outcome were analyzed. A total number of 14 patients underwent robotic biliary surgery for a variety of benign and malignant indications between September 2020 and May 2021. Six of fourteen patients (43%) had previous open abdominal surgery. Median blood loss was 25 mL (range 10–120 mL). There were no intra-operative complications and no conversions. Length of stay was between 3 and 11 days without major postoperative morbidity. Robotic surgery for benign and malignant bile duct obstruction is efficient and safe in experienced hands. Referral to a high-volume expert center is, however, advised.

Keywords Robotic surgery · Bile duct · Biliary obstruction · Bilio-enteric anastomosis

Introduction

Surgery remains the treatment of choice for the majority of patients with benign and malignant biliary obstruction. Biliary obstruction may occur in a variety of situations ranging from benign biliary strictures to bile duct injuries following cholecystectomy and biliary malignancies. In most cases, a bilio-enteric anastomosis with or without bile duct resection is a sufficient method to relieve biliary obstruction. In general, biliary surgery requires fine dissection and advanced suturing.

Laparoscopic bile duct surgery has recently been shown to be a safe treatment option for selected patients with choledochal cysts [1, 2]. Reports on laparoscopic surgery for biliary obstruction are scarce and these procedures are generally performed by an open approach. The introduction of robotic surgery has, however, allowed for better three-dimensional visualization, tremor filtering, increased dexterity and ease of suturing. Due to these advantages, recent multicenter studies report favourable results of robotic surgery compared to conventional laparoscopic surgery for pancreas and liver resections. This includes decreased rates of conversion for pancreatic surgery and potential technical advantages in high-demanding liver resections [3–6].

Until now, only few case series have been published describing the role of robotic surgery in patients with biliary obstruction [7]. The aim of this paper is to report our initial experience and feasibility of robotic bile duct surgery in a group of patients with biliary obstruction due to a variety of causes.

✉ Mathieu D'Hondt
mathieudhondt2000@yahoo.com

Dennis A. Wicherts
DennisAndre.Wicherts@zol.be

[1] Department of Digestive and Hepatobiliary/Pancreatic Surgery, Groeninge Hospital, President Kennedylaan 4, 8500 Kortrijk, Belgium

[2] Department of Abdominal and Hepatobiliary/Pancreatic Surgery, Ziekenhuis Oost-Limburg, Schiepse Bos 6, 3600 Genk, Belgium

Materials and methods

Robotic hepatobiliary surgery was introduced in our center in the beginning of 2020. Initial robotic experience was gained with inguinal hernia cases, distal pancreatectomies and minor liver resections. Following our progressive experience with advanced robotic pancreatic and liver surgery, patients requiring complex bile duct surgery were consecutively selected for minimally invasive robotic surgery by surgeon preference from September 2020. There were no exclusion criteria for a robotic approach. Patients who underwent a pancreatoduodenectomy were not selected for this analysis as they represent a different patient category.

The indication for surgery was discussed by a multidisciplinary team for all cases. All patients underwent preoperative evaluation with computed tomography imaging and magnetic resonance imaging with cholangiopancreatography to define biliary anatomy.

Information regarding patient demographics, indication for surgery, intra-operative details and postoperative course were prospectively collected in our database. Institutional review board approval and written consent was not needed for this analysis.

Surgical technique

All surgeries were undertaken using the da Vinci Xi Surgical System® (Intuitive Surgical, Sunnyvale, CA, USA). Patients were placed in supine position with legs parted and a laparoscopic assistant standing between the legs. The operating table was placed in slight reverse Trendelenburg (12 degrees). Three robotic 8 mm trocars were placed in a straight line two hands below the xiphoid with a fourth trocar on the left side slightly more cranially (Fig. 1A). One or two additional 12 mm assistant trocars were generally placed in the lower abdomen in between two robotic trocars. The robot was docked, coming from the patient's right side.

Meticulous dissection of the liver hilum was generally done using the monopolar robotic hook, monopolar scissors and bipolar Maryland or bipolar forceps. Robotic ultrasound and indocyanine green were used selectively to assess individual biliary and vascular anatomy. In cases where a liver resection was performed, parenchymal dissection was done using the Kelly clamp crush technique with robotic Maryland and robotic vessel sealer. In general, total pedicular clamping was used during parenchymal dissection to reduce blood loss.

When a bilio-enteric anastomosis was needed, a Roux-en-Y loop was prepared 30 to 40 cm from Treitz ligament which was divided by an endoscopic stapler. The distal loop was brought to the liver hilum through a mesocolonic window to create a tension-free anastomosis. Since most patients had dilated bile ducts in this series, the hepaticojejunostomy was generally performed end-to-side using two separate resorbable v-loc™ 4/0 (Covidien, Mansfield, MA, USA) running sutures for the anterior and posterior wall (Fig. 1B). Both threads were progressively tightened and locked together

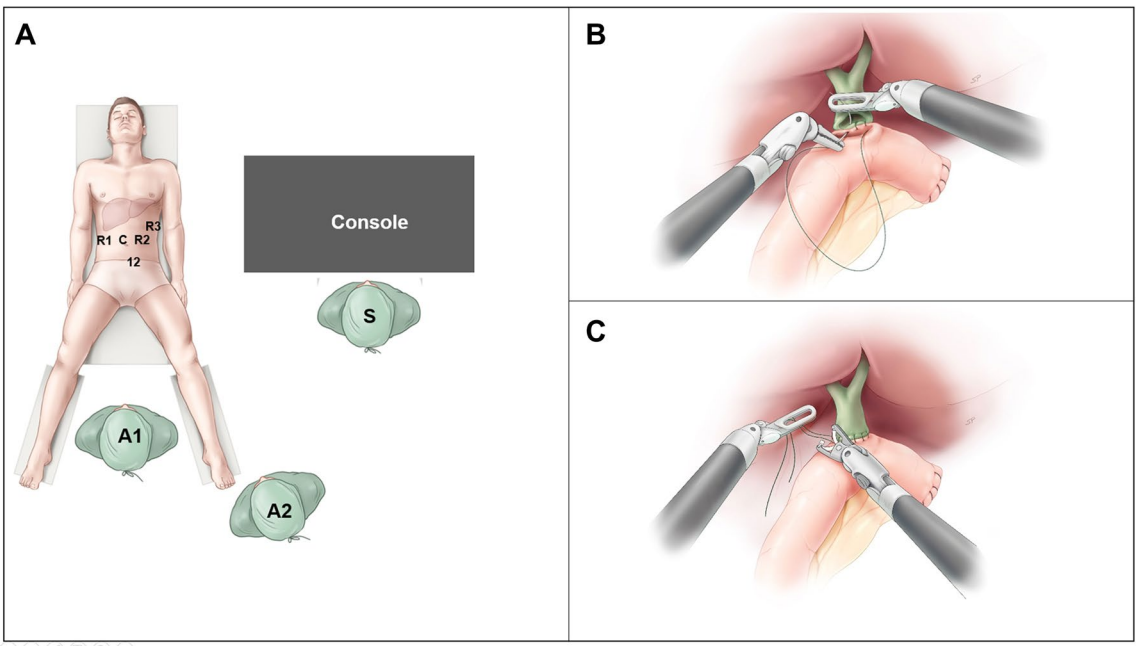

Fig. 1 **A** Port placement for robotic complex biliary reconstruction; **B** creation of the posterior layer of the hepaticojejunostomy; **C** locking both threads of the anterior and posterior layer with a Hem-o-lok clip

with a Hem-o-lok clip (Weck Closure Systems, Research Triangle Park, NC, USA) after finishing the anastomosis (Fig. 1C). In patients with non-dilated bile ducts, the hepaticojejunostomy is usually performed using separate sutures with vicryl 4/0 for the anterior and posterior wall. In case of slight dilated bile ducts, we sometimes use a running v-loc™ 4/0 suture for the posterior wall and separate vicryl 4/0 sutures for the anterior wall. In patients with separated bile ducts that need a bilio-enteric diversion (for example right and left duct or right anterior and right posterior duct), we generally perform a double barrel anastomosis resulting in a single hepaticojejunostomy (Fig. 2A).

An intracorporeal robotic end-to-side entero-enterostomy was made 60 cm more distally. The anastomosis was a two layered anastomosis using two layers of a resorbable v-loc™ 3/0 running suture. In recent cases, we used a small syringe with a fine needle to inject blue dye in the common limb to guide possible future endoscopic retrograde cholangiopancreatography (Fig. 2B).

In all cases, a silicone drain was placed near the hepaticojejunostomy to detect postoperative bile leakage.

Postoperative outcome

The surgical drain was removed on postoperative day 2 when drain production was negative for bile. Postoperative complications were classified using the Clavien–Dindo classification [8]. After discharge, patients were followed in our outpatient clinic at 1 month after surgery and on indication thereafter.

Statistical analysis

Descriptive statistics including percentages, medians and ranges were calculated using Microsoft Excel (Microsoft, Redmond, WA, USA).

Results

Between September 2020 and May 2021, 14 patients underwent robotic biliary surgery for benign and malignant biliary obstruction (Table 1). In the same period, 113 other patients had robotic hepatobiliary surgery, including 35 pancreatic resections (pancreatoduodenectomy or distal pancreatectomy) and 78 liver resections. Since the start of our learning curve, before starting complex robotic biliary surgery, we had performed already 42 technically or anatomically major robotic hepatic resections and 22 pancreatic resections. Our experience with robotic pancreaticoduodenectomy was useful to gain experience in constructing bilio-enteric anastomosis before starting complex robotic biliary surgery.

This series of patients that had robotic biliary surgery included 4 males and 10 females between 23 and 77 years old (median age: 66 years) (Table 2). Eight of fourteen patients (57%) were referred to us from other hospitals. Injury to the common bile duct following cholecystectomy

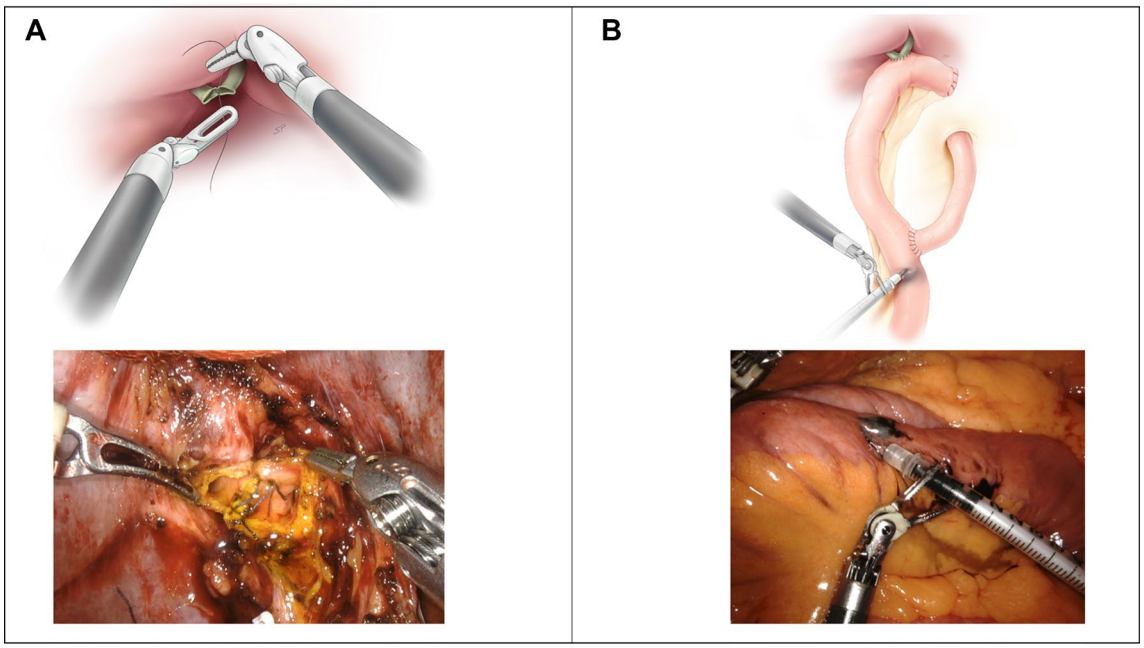

Fig. 2 **A** Double barrel anastomosis of the right and left hepatic duct; **B** common limb tattoo following Roux-en-Y hepaticojejunostomy to guide possible future ERCP

Table 1 Indications for surgery and performed robotic procedures

ID	Indication for surgery	Robotic procedure
1	CBD injury Strasberg E2 (8 years after CCE) with recurrent cholangitis and abscesses left lateral sector	HJ + left lateral sectionectomy
2	HJ stenosis 18 months after open Whipple. Unsuccessful PTC dilatations	Redo HJ
3	Large metastatic duodenal tumor with biliary obstruction + gastric outlet obstruction. No possibility for ERCP	HJ + gastroenterostomy
4	Gallbladder cancer with positive frozen section cystic duct	Segment IVb/V resection + CCE + LNs + CBD resection + HJ
5	Mirizzi type IV with cholecystocolic fistula	CCE + CBD resection + wedge resection colon with Heineke–Mikulicz plasty + HJ
6	CBD injury Strasberg E4 (many years after CCE) with recurrent cholangitis + abscesses left liver lobe	Left hepatectomy + CBD resection + HJ right liver
7	CBD injury Strasberg E4 (many years after CCE) with recurrent cholangitis	CBD resection + double barrel anastomosis right and left duct + HJ
8	Mirizzi type III	Partial CCE with stone removal + choledochoplasty with the remaining wall of the gallbladder
9	Mirizzi type IV	CCE with removal of three giant stones + HJ
10	CCE with right hepatic duct injury followed by hepaticoduodenostomy with recurrent stricture and cholangitis	Takedown hepaticoduodenostomy + HJ on right hepatic duct (separate anterior and posterior branch)
11	HJ stenosis after open left hepatectomy with bile duct resection + HJ for hilar cholangiocarcinoma	Redo HJ
12	Perihilar cholangiocarcinoma Bismuth–Corlette type IV	Left hepatectomy + segment I + resection extrahepatic bile duct + LNs + HJ on right hepatic duct (separate anterior and posterior branch)
13	Bile duct stenosis following open right trisectionectomy for giant hemangioma	Hepaticoduodenostomy (separate bile duct of segment 2 and 3)
14	CBD narrowing following open radical cholecystectomy for high-grade dysplasia	CBD resection + double barrel anastomosis right posterior duct and common hepatic duct + HJ

CBD common bile duct, *CCE* cholecystectomy, *HJ* hepaticojejunostomy, *PTC* percutaneous transhepatic cholangiogram, *ERCP* endoscopic retrograde cholangiopancreatography, *LN* lymph node

was the main indication for surgery (4 patients). Other indications included complicated gallstone disease (3 patients), malignant disease (4 patients) and benign biliary strictures following open surgery (3 patients). Six of fourteen patients (43%) had previous open abdominal surgery.

In addition to biliary reconstruction, additional liver resections were performed in 4 patients, including two major hepatectomies. One patient underwent additional closure of a cholecystocolic fistula with wedge resection of the colon and Heineke–Mikulicz plasty (patient nr. 5) (Fig. 3) and another patient had a choledochoplasty with the remaining wall of the gallbladder (patient nr 8) [9, 10].

Operative characteristics

Median operative time was 205 min (range 135–360 min) (Table 2). Most cases were completed within 4 h surgical time. Only one patient with a type IV perihilar cholangiocarcinoma that underwent a left hepatectomy with segment I and resection of the extrahepatic bile duct with lymphadenectomy with a hepaticojejunostomy on the separate right anterior and posterior branch had a significant longer operative time of 360 min (patient nr 12). The other patient that underwent a concomitant left hepatectomy had a history of recurrent abscesses in the left liver lobe due to a common bile duct injury following cholecystectomy (patient nr. 6). Operative time in this patient was 270 min.

Median blood loss was 25 mL (range 10–120 mL). There were no intra-operative complications or technical issues and no conversions.

Postoperative outcome

Postoperative length of stay ranged between 3 and 11 days (median: 6 days). Eleven patients were discharged within 7 days after surgery. One patient in whom a previous hepaticoduodenostomy was converted to a hepaticojejunostomy on the right hepatic duct had a postoperative bile leak that resolved on postoperative day 8 (Clavien–Dindo grade I) (patient nr. 10). She had concomitant delayed gastric emptying and was discharged on day 11. Another patient also had a postoperative bile leak that resolved on postoperative day 8 (Clavien–Dindo grade I) (patient nr 13). One other patient had delayed gastric emptying that needed a gastric tube for

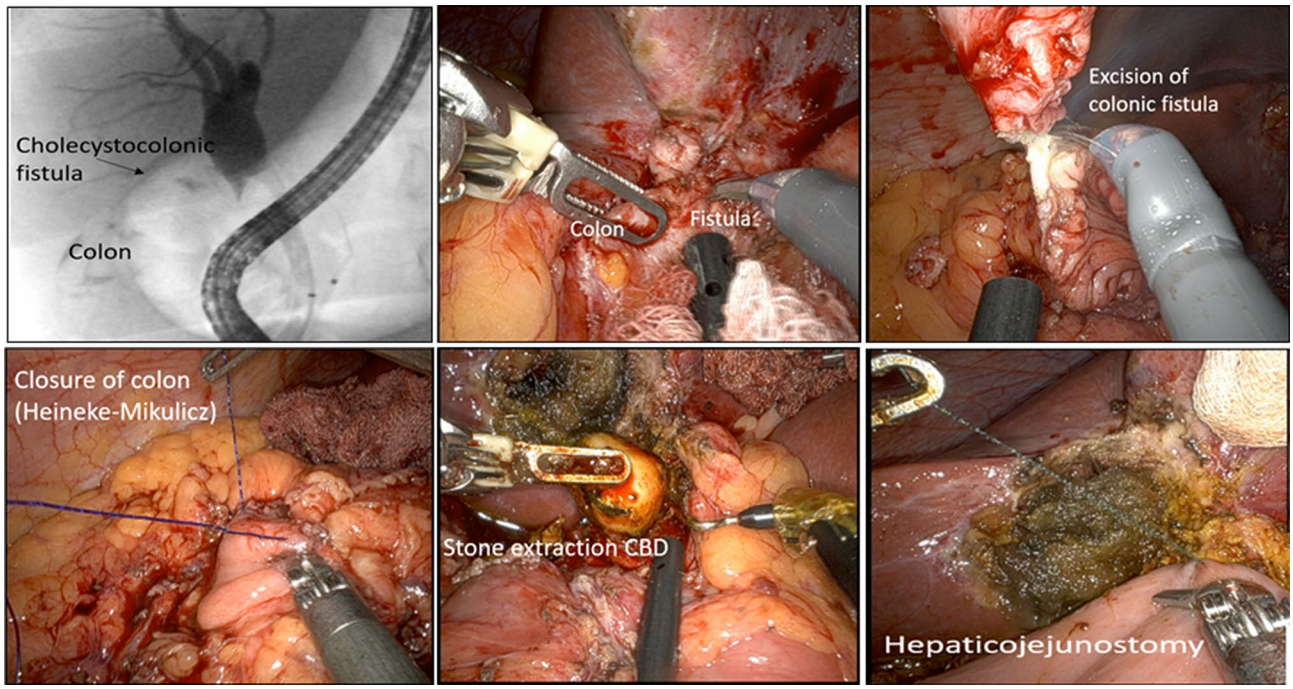

Fig. 3 Mirizzi type IV with cholecystocolic fistula

Table 2 Patient and operative characteristics and postoperative outcome

ID	Indication	Sex	Age (years)	BMI (kg/m^2)	Previous abdominal surgery	Operative time (min)	Blood loss (mL)	Conversion	Length of stay (days)
1	Benign	F	64	21.1	Open cholecystectomy	200	100	No	7
2	Benign	F	75	18.4	Open Whipple Laparoscopic TME Laparoscopic partial hepatectomy	180	10	No	5
3	Malignant	M	63	23.5	None	210	10	No	6
4	Malignant	M	65	28.0	None	250	40	No	3
5	Benign	F	69	30.9	None	240	30	No	6
6	Benign	M	66	29.2	Laparoscopic cholecystectomy	270	120	No	5
7	Benign	F	66	31.6	Laparoscopic cholecystectomy	170	30	No	7
8	Benign	F	62	22.6	None	135	10	No	3
9	Benign	M	67	26.4	None	200	10	No	6
10	Benign	F	23	23.0	Laparoscopic cholecystectomy Open hepaticoduodenostomy	210	20	No	11
11	Benign	F	55	28.9	Open left hepatectomy + bile duct resection + HJ	180	30	No	5
12	Malignant	F	70	27.2	None	360	100	No	11
13	Benign	F	40	28.0	Laparoscopic gastric bypass Laparoscopic cholecystectomy Open right trisectionectomy	275	20	No	10
14	Malignant	F	77	37.0	Open radical cholecystectomy	180	10	No	3

BMI body mass index, *TME* total mesorectal excision, *HJ* hepaticojejunostomy

five days and total parenteral nutrition (Clavien–Dindo grade II). She was also discharged on postoperative day 11 (patient nr 12).

Discussion

Recently, robotics has been introduced in different fields of abdominal surgery as it is able to overcome most of the major limitations of conventional laparoscopy. Surgery of the biliary tree is technically demanding with fine dissection and advanced suturing limiting a standard laparoscopic approach. In most centers, complex biliary reconstruction is, therefore, most often performed by an open approach. The robotic platform allows for enhanced visualization, increased stability and dexterity creating the possibility of complex minimally invasive manoeuvres. The use of robotic surgery for complex biliary problems is, however, still scarce [11].

In this series, we describe the application of robotic surgery in a variety of patients with complex benign and malignant biliary obstruction. In most of these cases, a bilio-enteric anastomosis is necessary to provide a definitive treatment with sufficient biliary drainage. The results in our paper show that complex robotic biliary reconstruction is feasible with minor morbidity and limited length of stay. Also, median blood loss was less than 50 mL. Moreover, we experienced no conversions although almost half of patients had previous open upper abdominal surgery. Also, a number of patients underwent a concomitant robotic hepatectomy.

In the current literature, mostly anecdotal case reports regarding robotic biliary surgery have been published so far. This mainly concerns robotic-assisted hepaticojejunostomy following bile duct injury after cholecystectomy [12–17]. Cuendis-Velazquez et al. describe a series of 30 consecutive patients and report that robotic hepaticojejunostomy can be performed safely with acceptable short-term results [18]. Another series of 12 patients confirm these results with, however, higher blood loss [19]. One study from southeast Asia included 10 robotic hepaticojejunostomies (including two pancreatoduodenectomies) in a total series of 27 robotic biliary cases. They also showed a low anastomotic complication rate [20]. The largest series of robotic hepaticojejunostomies includes 152 consecutive patients of whom 96 had a pancreatoduodenectomy [21, 22]. They reported similar rates of anastomotic leak and strictures as compared to open surgery. Other published case reports describe successful choledochal cyst excision with hepaticojejunostomy [23–25].

We included a mix of patients including three patients with Mirizzi syndrome (type III and IV) [26]. In such complicated cases, a conventional laparoscopic approach is associated with high conversion rates to open surgery [27]. However, using the robotic platform, we successfully managed a case of cholecystocolic fistula with dense surrounding inflammation as well as a large choledochal defect that was closed using the remaining gallbladder wall that was discharged uneventfully on postoperative day 3 [9].

Regarding our technique for the construction of the hepaticojejunostomy we generally used two separate v-loc™ 4/0 (Covidien, Mansfield, MA, USA) running sutures for the anterior and posterior wall that are locked together with a Hem-o-lok clip since most patients had a dilated common bile duct. Some authors suggest that continuous suturing carries a risk of anastomotic strictures, especially in patients with non-dilated bile ducts [28]. However, this was not confirmed in a recently reported large robotic series [21]. Indeed, we believe that a running suture with a single thread may lead to a narrow anastomosis. However, in case of dilated bile ducts, the tension-free locking of both threads with a clip instead of tightening them together might help to overcome the risk of anastomotic strictures. The follow-up in our series is, however, too short to analyze this hypothesis.

For patients with biliary obstruction, a Roux-en-Y hepaticojejunostomy is the preferred technique of reconstruction in our center. However, in one patient who previously had a gastric bypass (patient nr. 13), we performed a hepaticoduodenostomy to avoid the construction of a second Roux-en-Y limb and changing the length of the common channel. Indeed, it was previously showed that a hepaticoduodenostomy is a safe technique in selected patients [29].

The additional costs of robotic surgery compared to open or standard laparoscopic surgery are frequent mentioned as limiting factor in its wide implementation. However, the possibility to perform complex biliary surgery in a minimally invasive way will certainly result in a decreased length of hospital stay. The enhanced visualization and dexterity of the robotic platform may possibly also lead to a lower anastomotic complication rate favoring the use of robotic surgery. The three-dimensional view also facilitates adhesiolysis after previous open surgery with a negligible risk of conversion to open surgery.

Biliary surgery and reconstruction for benign and malignant diseases is generally considered as complex surgery that needs referral to specialized centers to optimize patient outcome [30, 31]. Even more, when performed robotically, sufficient robotic case load and experience is of significant importance.

Conclusion

Robotic surgery for benign and malignant bile duct obstruction is efficient and safe in experienced hands. Our previous experience with robotic and laparoscopic hepatobiliary surgery has possibly favored these positive outcomes.

Nonetheless, robotics overcome most of the major limitations of conventional laparoscopic surgery required for advanced biliary surgery. By this way, these complex patients can also have the advantages of minimally invasive surgery. Referral to a high-volume expert center is, however, advised and further matched comparison with open and laparoscopic procedures is warranted.

Author contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by MD and DW. The first draft of the manuscript was written by MD and Dr. DW and both authors commented on previous versions of the manuscript. Both authors read and approved the final manuscript.

Funding Dr. Mathieu D'Hondt and Dr. Dennis Wicherts declare that no funds, grants, or other support were received during the preparation of this manuscript.

Declarations

Conflict of interest Dr. Mathieu D'Hondt and Dr. Dennis Wicherts have no relevant financial or non-financial interests to disclose.

Ethical approval This study did not require ethics approval.

Consent to participate Not applicable.

Consent to publish Not applicable.

References

1. Jang JY, Yoon YS, Kang MJ, Kwon W, Park JW, Chang YR, Ahn YJ, Cho JY, Han HS, Kim SW (2013) Laparoscopic excision of a choledochal cyst in 82 consecutive patients. Surg Endosc 27:1648–1652
2. Hwang DW, Lee JH, Lee SY, Song DK, Hwang JW, Park KM, Lee YJ (2012) Early experience of laparoscopic complete en bloc excision for choledochal cysts in adults. Surg Endosc 26:3324–3329
3. Lof S, Vissers FL, Klompmaker S, Berti S, Boggi U, Coratti A, Dokmak S, Fara R, Festen S, D'Hondt M, Khatkov I, Lips D, Luyer M, Manzoni A, Rosso E, Saint-Marc O, Besselink MG, Abu Hilal M (2021) Risk of conversion to open surgery during robotic and laparoscopic pancreatoduodenectomy and effect on outcomes: international propensity score-matched comparison study. Br J Surg 108:80–87
4. Lof S, van der Heijde N, Abuawwad M, Al-Sarireh B, Boggi U, Butturini G, Capretti G, Coratti A, Casadei R, D'Hondt M, Esposito A, Ferrari G, Fusai G, Giardino A, Groot Koerkamp B, Hackert T, Kamarajah S, Kauffmann EF, Keck T, Marudanayagam R, Nickel F, Manzoni A, Pessaux P, Pietrabissa A, Rosso E, Salvia R, Soonawalla Z, White S, Zerbi A, Besselink MG, Abu Hilal M (2021) Robotic versus laparoscopic distal pancreatectomy: multicentre analysis. Br J Surg 108:188–195
5. Ciria R, Berardi G, Alconchel F, Briceño J, Choi GH, Wu YM, Sugioka A, Troisi RI, Salloum C, Soubrane O, Pratschke J, Martinie J, Tsung A, Araujo R, Sucandy I, Tang CN, Wakabayashi G (2020) The impact of robotics in liver surgery: a worldwide systematic review and short-term outcomes meta-analysis on 2,728 cases. J Hepatobiliary Pancreat Sci. https://doi.org/10.1002/jhbp.869
6. Sucandy I, Giovannetti A, Ross S, Rosemurgy A (2020) Institutional first 100 case experience and outcomes of robotic hepatectomy for liver tumors. Am Surg 86:200–207
7. Guerra F, Di Marino M, Coratti A (2019) Robotic surgery of the liver and biliary tract. J Laparoendosc Adv Surg Tech A 29:141–146
8. Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, de Santibañes E, Pekolj J, Slankamenac K, Bassi C, Graf R, Vonlanthen R, Padbury R, Cameron JL, Makuuchi M (2009) The Clavien-Dindo classification of surgical complications: five-year experience. Ann Surg 250:187–196
9. Sandblom P, Tabrizian M, Fluckiger A (1975) Repair of common bile duct defects using the gallbladder or cystic duct as a pedicled graft. Surg Gynecol Obstet 140:425–432
10. Waisberg J, Corona A, de Abreu IW, de Matos Farah JF, Lupinacci RA, Goffi FS (2005) Benign obstruction of the common hepatic duct (Mirizzi syndrome): diagnosis and operative management. Arq Gastroenterol 42:13–18
11. Chang K, Gokcal F, Kudsi OY (2020) Robotic biliary surgery. Surg Clin N Am 100:283–302
12. Benzie AL, Sucandy I, Spence J, Ross S, Rosemurgy A (2019) Robotic choledochoduodenostomy for benign distal common bile duct stricture: how we do it. J Robot Surg 13:713–716
13. Prasad A, De S, Mishra P, Tiwari A (2015) Robotic assisted Roux-en-Y hepaticojejunostomy in a post-cholecystectomy type E2 bile duct injury. World J Gastroenterol 21:1703–1706
14. Machado MA, Surjan RC, Ardengh AO, Makdissi F (2019) Robotic left hepatectomy and Roux-en-Y hepaticojejunostomy after bile duct injury. Ann Surg Oncol 26:2981–2984
15. Machado MA, Ardengh AO, Makdissi FF (2020) Robotic Roux-en-Y hepaticojejunostomy for primary intrahepatic lithiasis after laparoscopic right hepatectomy. Arq Gastroenterol 57:337–338
16. Sucandy I, Castro M, Krill E, Ross S, Rosemurgy A (2021) Robotic RY hepaticojejunostomy for Strasberg E4 iatrogenic bile duct injury: a modern minimally invasive technique. Am Surg. https://doi.org/10.1177/0003134821989030
17. Sucandy I, Durrani H, Giovannetti A, Spence J, Ross S, Rosemurgy A (2020) Robotic Roux-en-Y hepaticojejunostomy with arterial repair for biliovascular injury following laparoscopic cholecystectomy. Am Surg. https://doi.org/10.1177/0003134820956336
18. Cuendis-Velázquez A, Bada-Yllán O, Trejo-Ávilla M, Rosales-Castañeda E, Rodríguez-Parra A, Moreno-Ordaz A, Cárdenas-Lailson E, Rojano-Rodríguez M, Sanjuan-Martínez C, Moreno-Portillo M (2018) Robotic-assisted Roux-en-Y hepaticojejunostomy after bile duct injury. Langenbecks Arch Surg 403:53–59
19. Marino MV, Mirabella A, Guarrasi D, Lupo M, Komorowski AL (2019) Robotic-assisted repair of iatrogenic common bile duct injury after laparoscopic cholecystectomy: surgical technique and outcomes. Int J Med Robot. https://doi.org/10.1002/rcs.1992
20. Goh BKP, Low TY, Teo JY, Lee SY, Chan CY, Chung AYF, Ooi LLPJ (2019) Initial single institution experience with robotic biliary surgery and bilio-enteric anastomosis in southeast Asia. ANZ J Surg 89:e142-146
21. Bustos R, Fernandes E, Mangano A, Aguiluz G, Valle V, Masrur M, Bianco F, Giulianotti PC (2020) Robotic hepaticojejunostomy: surgical technique and risk factor analysis for anastomotic leak and stenosis. HPB 22:1442–1449
22. Giulianotti PC, Quadri P, Durgam S, Bianco FM (2018) Reconstruction/repair of iatrogenic biliary injuries: is the robot offering a new option? Short clinical report. Ann Surg 267:e7-9
23. Akaraviputh T, Trakarnsanga A, Suksamanapun N (2010) Robot-assisted complete excision of choledochal cyste type I,

hepaticojejunostomy and extracorporeal Roux-en-Y anastomosis: a case report and review literature. World J Surg Oncol 8:87
24. Woo R, Le D, Albanese CT, Kim SS (2006) Robot-assisted laparoscopic resection of a type I choledochal cyst in a child. J Laparoendosc Adv Surg Tech A 16:179–183
25. Kang CM, Chi HS, Kim JY, Choi GH, Kim KS, Choi JS, Lee WJ, Kim BR (2007) A case of robotic-assisted excision of choledochal cyst, hepaticojejunostomy, and extracorporeal Roux-en-Y anastomosis using the da Vinci surgical system. Surg Laparosc Endosc Percutan Tech 17:538–541
26. Csendes A, Diaz JC, Burdiles P (1989) Mirizzi syndrome and cholecystobiliary fistula: a unifying classification. Br J Surg 76:1139–1143
27. Erben Y, Benavente-Chenhalls LA, Donohue JM, Que FG, Kendrick ML, Reid-Lombardo KM, Farnell MB, Nagorney DM (2011) Diagnosis and treatment of Mirizzi syndrome: 23-year Mayo Clinic experience. J Am Coll Surg 213:114–119
28. Natsume S, Shimizu Y, Okuno M, Kawakatsu S, Matsuo K, Hara K, Ito S, Komori K, Abe T, Nagino M (2021) Continuous suture is a risk factor for benign hepaticojejunostomy stenosis after pancreatoduodenectomy in patients with a non-dilated bile duct. HPB. https://doi.org/10.1016/j.hpb.2021.04.010
29. Luu C, Lee B, Stabile BE (2013) Choledochoduodenostomy as the biliary-enteric bypass of choice for benign and malignant distal common bile duct strictures. Am Surg 79:1054–1057
30. Jajja MR, Laboe A, Hashmi S, Nadeem SO, Sayed BA, Sarmiento JM (2021) Standardizing diagnostic and surgical approach to management of bile duct injuries after cholecystectomy: long-term outcomes of patients treated at a high-volume HPB center. J Gastrointest Surg 25:2796–2805
31. Cillo U, Fondevila C, Donadon M, Gringeri E, Mocchegiani F, Schlitt HJ, Ijzermans JNM, Vivarelli M, Zieniewicz K, Olde Damink SWM, Groot Koerkamp B (2019) Surgery for cholangiocarcinoma. Liver Int 39(Suppl 1):143–155