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ORIGINAL ARTICLE

Long-Term Outcome of Revision Hepaticojejunostomy in Postcholecystectomy Bile Duct Stricture: A Tertiary Center Experience

Kanhaiya Lal Chaudhary[1] · Ashok Kumar[1] · Rajan Saxena[1] · Rahul[1] · Anu Behari[1]

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Abstract
Benign bile duct stricture (BBS) can lead to recurrent cholangitis, biliary cirrhosis, hepatic failure, and death if untreated. Although excellent outcomes can be achieved by Roux-en-Y hepaticojejunostomy (RYHJ), in the majority of patients with BBS, a subset of patients can have recurrent anastomotic site strictures requiring revision Roux-en-Y hepaticojejunostomy (rRYHJ). This study is a review of patients undergoing revision Roux-en-Y hepaticojejunostomy. Case series analysis of retrospective data from patients undergoing rRYHJ from January 1989 to December 2020 was conducted. Their demographic, preoperative, intraoperative, and postoperative outcomes were analyzed. A total of 44 (6.98%) patients had recurrent anastomotic site strictures among 630 patients who had undergone RYHJ (Roux-en-Y hepaticojejunostomy) for benign biliary stricture following bile duct injury at a minimum follow-up of 3 years. Among 44 patients, 36 patients (81.8%) underwent rRYHJ (revision Roux-en-Y hepaticojejunostomy). Their mean age was 48.5 years, and the majority were women with 26 (59%) of the patients. The mean duration between primary (RYHJ) and revision (rRYHJ) was 5.5 years. Thirty-two (88.8%) patients presented with cholangitis, and one patient (2.7%) had cirrhosis. Twenty-four (75%) patients underwent preoperative biliary drainage. Types of re-strictures (on the basis of intraoperative assessment) according to bismuth classification included type I 1 (2.78%), type II 3 (8.3%), type III 20 (55.5%), type IV 10 (27.8%), and type V 2 (5.5%). Twelve patients (33%) had postoperative complications, and the most common complication was surgical site infection ($n = 8$, 22.2%). There was no mortality. Two patients had postoperative bile leakage, managed conservatively (Clavien-Dindo (CD) grade I). On long-term follow-up (mean 5.5 years), satisfactory outcomes (A and B McDonald's grade) were observed in 31 (86%) patients, 3 (8.3%) patients had grade C outcomes, and 2 (5.5%) patients had grade D outcomes. Overall, 29.5% (13) of cases, including 6 cases of bile duct stricture after the first RYHJ and 5 cases of re-stricture after revision r-RYHJ, were managed successfully with balloon dilation and ring biliary catheter, showing better long-term outcomes. Our study has shown that the overall post-revision Roux-en-Y hepaticojejunostomy (rRYHJ) long-term outcome was satisfactory in 86% of patients according to McDonald's grading. A multidisciplinary approach in high-volume center is paramount important to obtaining a good long-term outcome.

Keywords Long-term outcome · Recurrent anastomotic stricture · Bile duct stricture

✉ Ashok Kumar
drashok97@gmail.com

Kanhaiya Lal Chaudhary
dr.klc09@gmail.com

Rajan Saxena
rajansaxena1959@gmail.com

Rahul
rahurahulimsbhu@gmail.com

Anu Behari
anubehari@yahoo.co.in

[1] Department of Surgical Gastroenterology Sanjay Gandhi Post Graduate Institute of Medical Sciences, Raebareli–Road, Lucknow, Uttar Pradesh, India 226014

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Introduction

In this present era, laparoscopic cholecystectomy is the gold-standard treatment of symptomatic gallstone disease [1]. Incidence of bile duct injury after open and laparoscopic cholecystectomy is respectively reported as 0.1–0.2% and 0.4–0.7%. Further introduction of technical advancement in the form of robot-assisted cholecystectomy was found to have a higher rate of bile duct injury compared to laparoscopic cholecystectomy (0.4% vs 0.2%; RR, 1.88 [95% CI, 1.14–2.63]) [2–5]. Associated vascular injury, secondary biliary cirrhosis, hepatolithiasis, intrahepatic stricture, and inadequate technique of reconstruction which is especially performed by primary surgeons are the most common causes of anastomotic failure and re-stricture formation [6]. Post-cholecystectomy bile duct injury, repeated intervention, and surgeries cause great pain, trauma, and financial burden to the patients and their families [7, 8]. However, not all BDIs will lead to a benign biliary stricture (BBS). Approximately 30–60% of BDIs can develop BBS [9]. The first attempt of BBS repair is the best opportunity to achieve a good long-term outcome (79–93%) [9]. Studies have shown that approximately (11–40%) of the first Roux-en-Y biliary enteric bypass can develop re-stricture and require revision Roux-en-Y biliary enteric bypass [10–12]. Here in this study, we described our short-term and long-term outcomes of revision hepaticojejunostomy (HJ) for recurrent bile duct strictures.

Patients and Methods

The above study was a case series analysis of retrospective data, conducted in a tertiary care center in North India. Between January 1989 and December 2020, 44 consecutive patients with post-cholecystectomy bile duct strictures underwent Roux-en-Y hepaticojejunostomy and developed re-stricture. All patients were treated in our department.

The aim of the above study was to evaluate the long-term outcome of revision Roux-en-Y hepaticojejunostomy in cases of recurrent benign biliary stricture. Demographic, perioperative parameters (including laboratory results, imaging studies, and intraoperative findings), and long-term follow-up of patients who underwent revision Roux-en-Y hepaticojejunostomy (rRYHJ) for benign recurrent biliary strictures were analyzed.

Preoperative Assessment and Follow-Up

Besides all routine blood investigations, liver function tests, and renal function tests, we routinely performed preoperative triple-phase computed tomography (CT) (to delineate the parenchymal changes, atrophy hypertrophy complex, perihilar collaterals, and vascular injury involvement), magnetic resonance cholangiopancreatography (MRCP) to reveal the preoperative diagnosis and biliary strictures grading. According to our observation, MRCP failed to give accurate information, especially in the case of stricture above the type 3 grade. Because MRCP provides only the information of (un-stricture lumen) biliary tract, however, the accurate relation to the surrounding (liver parenchyma and surrounding vessel) remains unmatched and many times over or underestimates the grade of stricture. However, the relation to the surroundings remains unmatched (Fig. 1). To overcome the above problems, step-wise transhepatic cholangiography and radiography become necessary. In our study, we performed transhepatic cholangiography in recurrent stricture grade above type III to confirm preoperative diagnosis and biliary stricture degree.

Step 1: Left segment percutaneous transhepatic biliary drainage (PTBD) followed by cholangiogram, if connecting with the right biliary system, may not require right segment drainage.
Step 2: In case the cholangiogram does not show a bilateral (right duct and left duct) connection, we use one of the feasible (right anterior or right posterior) right-side PTBD.
Step 3: If the right segment cholangiogram does not form (right-sided) a secondary confluence, then we suggest a third PTBD in one of the remaining right-sided segment also. Bilirubin > 10 mg/dl, intractable itching, cholangitis, for the nutritional build-up, and pre-operative guidance to identify biliary duct remnant were our most common indications for percutaneous intervention. PTBD also has an added opportunity to get bile culture that can be utilized for prophylactic antibiotics during induction.

Initially, we used to do PTBD (high-grade stricture) just before the day of surgery, which left the ring biliary catheter more liable to dislodge during dissection and mobilizing; dislodgement of tubes always has a chance to bile leak over the surface of the liver. In that view, we adopted to wait for surgery about 2–3 weeks after PTBD which allows the forming of the fibrous tract between the liver surface and abdominal wall, which allowed us freedom of dissection without any fear of dislodgment.

On consideration of surgery, an end-to-side Roux-en-Y HJ was performed. The bile ducts were exposed proximal to the stricture, meticulous steps by dissection of supra-hepatic and sub-hepatic planes followed by identification of the previous anastomosis site. All the important landmarks like remnant cystic plate, umbilical fissure (left segment duct), and Rouviere's sulcus (right posterior seg duct) were

Fig. 1 A preoperative MR cholangiography showed stricture bile duct confluence at previous anastomotic site with left segment duct crowding

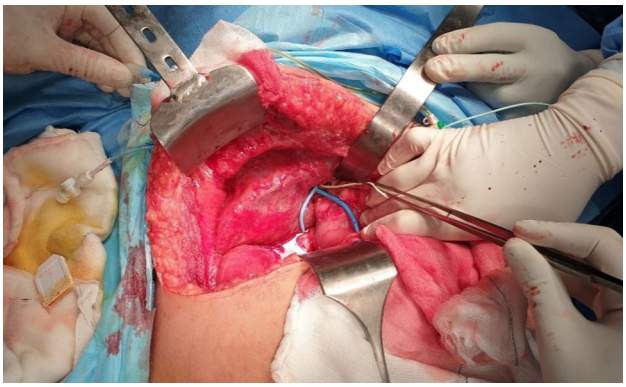

Fig. 2 Intraoperative imaging demonstrated all three PTBD catheters coming out from left segment, right anterior, and right posterior segments at anastomotic site

defined, and lowering of the hilar plate under segment VI of the liver was performed. The location of the remnant of the duct was confirmed with the help of needle aspiration, guide wire, and tactile sensation during PTBD tube manipulation (Fig. 2). Duct to mucosa anastomosis performed in continuous or interrupted methods with polydioxanon-suture (PDS) 4/0 or 5/0 suture. Postoperative long-term follow-up evaluation took place at 1, 3, and 6 months follow-up OPD cards/letter/telephonic/social media including WhatsApp/Telegram. Liver functions and USG abdomen were reviewed in order to evaluate postoperative complications. Postoperative complications and long-term outcomes were evaluated respectively based on the Clavein–Dindo classification system and McDonald's classification. The duration of follow-up was calculated from the date of the last intervention. The median duration of follow-up was 66 months.

Inclusion Criteria

All patients who underwent revision hepaticojejunostomy for benign biliary stricture were included.

Exclusion Criteria

Patients with hepaticojejunostomy stricture in malignant disease and other benign diseases except for benign biliary stricture repair were excluded.

Table 1 Demographic parameters of patients

Baseline characteristics	$n=44$
Age mean (SD)/range	48.5 SD16.8/(32–65)
Gender (M:F), *n* (%)	18 (41%):26 (59%)
Comorbidity, *n* (%)	8 (18.2%)
Duration between primary and revision Roux-en HJ (mean ± SD in years)/range (years)	5.5 SD3.0/(2.5–8.5)
Complications during prior surgery (initial RYHJ) CD I–IIIA, *n* (%)	$n=18$ (41%)
Type of vascular injury (arterial), (venous), *n* (%)	6 (13.6%), 2 (4.5%)
Bile leak during prior surgery (initial RYHJ), *n* (%)	$n=16$ (36.3%)
Type of stricture during prior surgery (initial RYHJ)	I-4 (9%) II-12 (27.2%) III-16 (36.3%) IV-10 (22.7%) V-2 (4.5%)

SD standard deviation

Statistical Analysis

Continuous variables are expressed as the mean, median, and range. Data are expressed as the mean (± standard deviation) or median ± IQR for quantitative variables. Absolute frequencies are expressed as percentage (%) for categorical variables.

Results

In our analysis, $n=40$ and $n=4$ cases respectively were included post-cholecystectomy bile duct injury and post-cholechochal cyst excision. Out of 44 HJ stricture cases, $n=28$ and $n=16$ cases respectively have undergone laparoscopic and open cholecystectomy. Out of 44 cases, $n=24$ patients of BBS were operated on by primary surgeons in small centers (after failure HJ/cholangiojejunostomy, they referred to our department), and $n=20$ patients were operated by expert surgeons at the institutional level. Out of 44 cases, $n=40$ and $n=4$ cases underwent hepaticojejunostomy and choledochojejunostomy, respectively. In our first 15 years of follow-up, bile duct injuries occurred most commonly after open cholecystectomy, and the latter half of the 15-year follow-up data showed a trend more after laparoscopic cholecystectomy. The average HJ stoma size in the first RYHJ was 1.5 cm while the redo RYHJ was 2.5 cm. In our study, demographic parameters, symptoms, and laboratory results at preoperative presentation are listed in Tables 1 and 2. Out of 44 patients, women were the most commonly affected gender component of 26 (59%), 8 (18.1%) patients had a vascular injury prior to initial RYHJ, and 16 (36.3%) patients had bile leak during prior surgery (initial RYHJ). Twenty-four (75%) patients required preoperative biliary drainage prior to revision RYHJ. Forty-four (6.98%) out of 630 patients developed post-HJ stricture in a minimum follow-up of 3 years, a median follow-up of 4.5 years, and a mean follow-up of 5.5 years. Among them, 36 (81.2%) patients underwent revision HJ. Twenty (55.5%) type 3 and 10 (27.78%) type 4 were the most common bismuth type of re-stricture occurring in patients (Table 3). Out of 44 cases,

Table 2 Preoperative parameters of patients

Hemoglobin (mean ± SD mg/dl)	12.2 ± 1.8
Preoperative bilirubin (mean ± SD mg/dl)	6.7 SD4.2
Total protein/albumin (mean ± SD g/dl)	6.3 SD1.2/3.3 SD0.36
SGOT/SGPT (mean ± SD IU/l)	86 SD18/102 SD24
Alkaline phosphate (mean ± SD IU/l)	380 SD35
PT INR (mean ± SD)	1.12 SD0.38
Recurrent cholangitis, *n* (%)	32 (88.8%)
Preoperative biliary drainage, *n* (%)	24 (75%)
Secondary biliary cirrhosis, *n* (%)	1 (2.7%)

Table 3 Intraoperative parameters of patients

Intraoperative factors	$n=36$
Size of stoma < 1.5 cm	12 (33.3%)
Suture techniques (continuous)	12 (33.3%)
Vascular injury	8 (22.2%)
Liver biopsy	4 (11.1%)
Bleeding more than 500 ml	8 (22.2%)
Blood loss (ml)	150 ± 50
Operative duration (min)	300 ± 60
Bismuth-type stricture	$n=36$
Type1	1 (2.78%)
Type2	3 (8.33%)
Type3	20 (55.5%)
Type4	10 (27.78%)
Type5	2 (5.55%)

Table 4 Postoperative parameters of patients

Parameters	$n = \%$
Postoperative complications	$n = 12$ (33.3%)
Wound infection (CDI)	8 (22.2%)
Anastomotic leak (CDIIIA)	2 (5.55%)
Post-operative bleeding (CDII)	1 (2.78%)
Cholangitis (CDII)	1 (2.78%)
Hospital stay (mean ± SD)/range (days)	10.4 SD4.4/(6–15)

CD Clavien-Dindo index, *SD* standard deviation

8 (18.2%) were managed conservatively with graded balloon dilatation and a ring biliary catheter. Among 36 revision Roux-en-Y hepaticojejunostomy patients, McDonald's grade C and D patients ($n = 5$) were managed with a minimally invasive-percutaneous approach. Postoperative complications occurred in 12 (33.3%); the most common complication was wound infection in 8 (22.2%). Out of 36 revision RYHJ patients, 3(8.33%) had mild cholestasis and 1 (2.7%) had secondary biliary cirrhosis (Table 4). The overall morbidity in revision RYHJ was 33.33%. There was no surgical procedure–related mortality.

Discussion

Post-cholecystectomy bile duct stricture management needs meticulous planning and biliary tract reconstruction; however, failure of hepaticojejunostomy reconstruction is associated with factors like vascular injury, preoperative bilirubin level, type of repair, stoma size, postoperative leaks, and surgery done by a primary or secondary surgeon. Revision Roux-en-Y HJ remains the most adopted and effective option for the treatment of HJ stricture. Ongoing inflammatory tissue reactions, around the portal hepatis, severe adhesion at target dissection plans, and dilemmatic anatomical changes especially secondary biliary cirrhosis, atrophy hypertrophy complex, rotation of liver, and collateral around the hepatoduodenal ligament further increase technical challenges for surgeons and leave the long-term outcomes unpredicted. In our study, 44(6.98%) out of 630 patients developed post-RYHJ stricture in a mean follow-up duration of 5.5 years, which is concordant with the study done by Barbier et al., 11.6% of patients who developed hepaticojejunostomy anastomotic stricture in a median interval of 63 months. Biliary strictures can develop anytime beyond 6 weeks up to 15 years after BDI [13]. In our study, intraoperative bismuth-type strictures were comparable with types I (17%), II (39%), III (35%), IV (7.3%), and V (1.2%) in the Tocchi et al. study [11] (Table 6). In our analysis, the revision RYHJ long-term outcome was satisfactory in 86% of patients, and McDonald's grades for long-term outcomes were excellent in 63.8%, good (22.2%), fair (8.33%), and poor (5.55%) cases (Table 5). All five patients of McDonald's grade C and D were managed conservatively with percutaneous intervention for intraabdominal collection, including bile leakage and organ space abscess after revision RYHJ, which is concordant with the study Benkabbou et al., where satisfactory outcomes are seen in 18 (82%) patients. Seventeen (94%) remained asymptomatic (Terblanche I–II), and 1 (6%) patient improved with few mild symptoms (Terblanche III), which later required percutaneous intervention. Four (9%) patients did not show any improvement in their symptoms (Terblanche IV) and managed with percutaneous intervention [14, 15]. Our above findings also match with study results, where clinical success (tube-free state) rates of gradual percutaneous intervention remain 67–88%, and the long-term successes in post-HJ stricture were highest for revision surgeries (84%), followed by percutaneous intervention (81%) and endoscopic treatment with multiple plastic stents (79%) or fully covered metallic stenting (76%) [16, 17] (Table 6).

In our study, no patient required hepatectomy or liver transplant, as observed in other studies, and this may be due to our closed 6-month regular follow-up (by follow-up OPD cards) even after the first initial year of hepaticojejunostomy, which allows us to diagnose HJ failure in a very early phase before they developed secondary biliary cirrhosis or un-drained atrophic liver segments. Some other studies have shown 1, 3, and 6 months of follow-up in the first initial year, rather than annually or only on developing clinical symptoms to force them to seek medical help. However, at that point, parenchymal structural damage already occurred [14, 18]. In our study, the overall morbidity of (CDI–IIIA) was 33.3%, and the mortality was nil in a mean follow-up of 5.5 years which was comparable to the study done by Benkabbou et al., whereas in the post-redo-RYHJ morbidity 11% (CDI–II), the overall mortality in both the redo RYHJ and percutaneous groups was nil in a mean follow-up of 49 ± 40 months [19]. In our study, five patients (13.8%) out of 36 (revision RYHJ) presented with recurrent cholangitis in a minimum follow-up of 36 months. This is comparable to the 14.2% of patients who developed recurrent cholangitis at a median interval of 48 months [20].

Table 5 Outcome of revision RYHJ according to McDonald's grade

McDonald's grading	$n = 36$	%
A	23	63.88
B	8	22.22
C	3	8.33
D	2	5.55

Table 6 Comparison of various studies of the long-term outcomes of benign biliary stricture repair

Authors	Number of patients	Previous biliary repair	Type of repair HJ	Duration (mean) follow-up	Long-term outcome	Development of SBC*
Pottakkat et al. (2007) [7]	300	$n=36$ (12%) Early repair 12 (33%) Delayed repair 24 (67%)	Revision Roux-en-Y HJ	37 months (range, 12–144 months)	$n=33$(94%) excellent/good outcome	
Sikora et al. (2006) [9]	300	$n=36$ (12%) prior repair	$n=292$ (97%)	9.5 years, $n=149$ (minimum 5 years follow-up)	Grades A and B: 90% Grades C and D: 5.4%	
Hamid et al. (2020) [14]	15	100% RYHJ	Revision Roux-en-Y = 10 $n=1$ transplant $n=4$ 9 (26.7%) percutaneous approach	6–8 months	Re-stricture 2 (13.3%) cases, 1 (6.7%) mortality	
Shalayiadang et al. (2022) [20]	61	34 traumatic biliary stricture 27 non-traumatic biliary stricture	Revision Roux-en-Y HJ	Traumatic biliary stricture (88.44 ± 35.67) months Non-traumatic biliary stricture (69.48 ± 36.61) months	Clavien–Dindo III and higher complications (16.4%, 10/61)	
Murr et al. [21]	59	47 (80%) 1 or more interventions ($n=34$) operative interventions	89.8% Roux-en-Y HJ others hepaticoduodenostomy, repair over T-tube	3.7 ± 0.3 years	85% excellent outcome, 6% good results 9% failure	-
Lillemoe et al. [22]	89	Surgical reconstruction ($n=59$)	100% Roux-en-Y HJ	28.5 months	79% excellent outcome,13% good outcome 8% failure	
Tocchi et al. [23]	42	22	100% Roux-en-Y HJ	92.4 ± 18.7 months	Good or excellent results 17 (77%) Fair or poor results 5 (23%)	
Present study (2024)	44	100% RYHJ	Revision Roux-en-Y HJ $n=36$ (81.8%)	5.5 years, $n=44$	Grade A—63.8% Grade B—22.2% Grade C—8.3% Grade D—5.5%	$n=1$(2.7%)

Conclusion

Hepaticojejunostomy failure is not a very uncommon complication. Closed and regular follow-up, after initial surgery, flawless preoperative planning, meticulous surgical technique, and undoubtedly enough experience are paramount important for satisfactory outcomes. The multidisciplinary approach of revision reconstruction and percutaneous intervention in a high-volume center is required to obtain a good long-term outcome. Our study has shown the overall post-revision Roux-en-Y hepaticojejunostomy (rRYHJ) long-term outcome was satisfactory in 86% of patients according to McDonald's grading. The long-term outcomes were excellent (63.8%), good (22.2%), fair (8.33%), and poor (5.55).

Declarations

Conflict of Interest The authors declare no competing interests.

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