ORIGINAL RESEARCH

Surgical Outcomes of Roux-en-Y Hepaticojejunostomy in a Plethora of Clinical Scenarios and the Credibility of Suture Techniques: Experience at a Single Indian Tertiary Care Center in Tamil Nadu

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Abstract

Background: Roux-en-Y hepaticojejunostomy (RYHJ) is the standard reconstructive procedure for restoring biliary continuity in a variety of benign biliary pathologies. Postoperative outcomes may be influenced by patient-related factors, inflammatory status, operative parameters, and anastomotic techniques.

Aim: This study evaluated surgical, functional, and quality of life (QoL) outcomes following elective RYHJ, with a comparison between interrupted and continuous suturing techniques.

Materials and methods: This single-center observational study included 121 patients who underwent elective RYHJ for benign biliary disease at a tertiary care hospital in Tamil Nadu. Patients with malignant biliary obstruction, emergency biliary reconstruction, pancreaticoduodenectomies, hepatectomies, liver transplantation, or incomplete follow-up were excluded. Preoperative, intraoperative, and postoperative variables were analyzed. Postoperative complications were graded using the Clavien–Dindo classification, functional outcomes were assessed using the McDonald classification, and QoL was evaluated using the WHOQOL-BREF questionnaire. Statistical analysis was performed using the Chi-square test or Fisher's exact test, with $p < 0.05$ considered statistically significant.

Results: Most patients were aged 31–60 years (68.6%), with a slight female predominance (54.5%). Interrupted anastomosis was performed in 82.6% of cases. Early postoperative complications occurred in 20.7% of patients, with bile leak observed in 18.2%, while late anastomotic strictures occurred in 11.6%. Major complications (Clavien–Dindo grade ≥ III) were seen in 17.4% of patients. On long-term follow-up, 71.9% achieved McDonald Grade A functional outcomes, and 87.6% demonstrated good or improved WHOQOL-BREF scores. No significant differences were observed between interrupted and continuous anastomotic techniques for any postoperative outcome ($p > 0.05$). Preoperative jaundice, cholangitis, hypoalbuminemia, prolonged operative duration, and increased intraoperative blood loss were significantly associated with higher complication rates ($p < 0.05$).

Conclusion: Elective RYHJ for benign biliary disease is associated with favorable surgical, functional, and QoL outcomes, with low rates of early and late complications. Interrupted and continuous anastomotic suturing techniques yield comparable postoperative results, indicating that patient-related and operative factors, rather than suturing technique, are the principal determinants of outcome.

Clinical significance: This study highlights that postoperative outcomes and QoL following RYHJ are influenced more by patient-related and disease-related factors than by the choice of suturing technique. These findings support a tailored surgical approach and emphasize optimization of patient condition and meticulous perioperative care to improve functional and QoL outcomes in benign biliary reconstruction.

Keywords: Benign biliary disease, Bile duct injury, McDonald classification, Modified Blumgart technique, Observational study, Postoperative outcomes, Quality of life, Roux-en-Y hepaticojejunostomy.

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Introduction

Roux-en-Y hepaticojejunostomy (RYHJ) is the preferred surgical procedure for restoring biliary continuity in a wide spectrum of benign and complex biliary pathologies, including bile duct injury (BDI), choledochal cysts, cholangiopathies, and benign biliary strictures.[1] Despite being commonly performed reconstruction, RYHJ remains a technically demanding operation that requires meticulous surgical technique and expertise to ensure durable anastomotic patency and prevent recurrent biliary obstruction.[2] Post-cholecystectomy BDI is one of the most frequent indications for hepaticojejunostomy (HJ), particularly in tertiary referral centers. When biliary reconstruction is attempted prematurely or without adequate preoperative optimization, patients are at increased risk of bile leak, anastomotic strictures, recurrent cholangitis, secondary

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biliary cirrhosis, and poor long-term quality of life (QoL).[1,2] Evidence suggests that outcomes are significantly improved when HJ is performed by specialized hepatobiliary teams, with low mortality rates and excellent long-term stricture-free survival.[2] Outcome variability persists due to differences in timing of referral, severity of injury, inflammatory status, and perioperative management. Hepaticojejunostomy is also indicated for other benign biliary strictures resulting from choledocholithiasis, hepatolithiasis, chronic biliary inflammation, congenital anomalies, and portal vein obstruction.

With advances in surgical techniques, minimally invasive approaches like laparoscopic and robotic HJ have increasingly been adopted, offering the potential for improved perioperative outcomes.[3] The most significant early postoperative complication following HJ comprises bile leak and its related septic complications, which require prompt recognition and management to optimize outcomes. Late complications, most notably anastomotic strictures, typically present months to years after surgery with jaundice and recurrent episodes of cholangitis, necessitating timely diagnosis and radiologic, endoscopic, or surgical interventions to prevent progressive biliary cirrhosis. Population-based studies estimate a postoperative stricture rate of approximately 12%, and while these strictures can be managed non-operatively, they remain clinically challenging.[4] Established risk factors for anastomotic stricture include bile duct ischemia, postoperative bile leak, and reconstruction performed by non-specialist surgeons.[5] Thus, both patient-related factors and operative variables contribute to the heterogeneity in outcomes following HJ.

With the growing use of minimally invasive and robotic techniques, increasing attention has been directed toward the technical aspects of biliary reconstruction, particularly the choice of anastomotic suturing technique. Although both continuous and interrupted suturing methods are commonly employed, comparative data evaluating their impact on bile leak rates and long-term anastomotic patency remain limited.[6] Long-term follow-up studies indicate that while many patients achieve satisfactory early functional recovery, delayed morbidity such as recurrent cholangitis requiring repeated hospital admissions and reinterventions can significantly impair QoL. Functional outcome scoring systems and structured follow-up protocols are essential to assess true long-term success beyond radiologic patency alone.[7] Quality of life studies demonstrate that patients undergoing repair for BDI may experience persistent physical and psychological limitations, particularly in the presence of postoperative complications.[8,9] The use of validated QoL assessment tools is crucial when evaluating the overall success of biliary reconstruction.

Data on HJ outcomes from high-volume Indian tertiary care centers remain limited. Most contemporary evidence on RYHJ is derived from pancreaticoduodenectomy, hepatectomy, or liver transplantation cohorts, where outcomes are confounded by the complexity of major hepatopancreatobiliary resections, as biliary reconstruction represents only one component of a complex operative course. Data specifically addressing isolated elective HJ for benign biliary disease remain limited. Therefore, the aim of this study was to evaluate the long-term outcomes of elective RYHJ in patients with benign biliary conditions, with particular emphasis on perioperative morbidity, early and late postoperative complications, long-term functional outcomes assessed using the McDonald classification, and QoL outcomes measured using validated instruments.

Materials and Methods

This observational study was conducted at a single tertiary care center in Tamil Nadu, India, and included 121 patients who underwent elective RYHJ for benign biliary diseases. Ethical approval was obtained from the Institutional Ethics Committee prior to the study (IEC No. MMC/Approval/05072024), and informed consent was obtained from all patients.

Inclusion Criteria

Patients of any age and sex who underwent RYHJ for benign biliary conditions, including iatrogenic bile duct strictures, choledochal cysts, choledocholithiasis, hepatolithiasis, Mirizzi syndrome, and portal biliopathy, and who had complete clinical, operative, and follow-up data available for analysis were included.

Exclusion Criteria

Patients were excluded if they underwent HJ for malignant biliary obstruction, if the procedure was performed as part of other major operations such as pancreaticoduodenectomy, hepatectomy, or liver transplantation, or if it was carried out as an emergency procedure. Patients with serious or uncontrolled comorbid illnesses, incomplete clinical or follow-up data, or those lost to follow-up were also excluded.

Methods

Clinical and Operative Assessment

All patients underwent a detailed preoperative clinical evaluation. Demographic details, underlying biliary diagnosis, comorbidities (diabetes mellitus and hypertension), presence of jaundice, cholangitis, preoperative biliary stenting, anemia, and hypoalbuminemia were recorded. Preoperative imaging findings and bile duct size were documented. The Bismuth–Strasberg classification of BDI was recorded where applicable. Following adequate preoperative nutritional and clinical optimization, all patients underwent elective surgical procedures like biliary stricture repair, biliary fistula takedown, extrahepatic bile duct excision, or bile duct exploration, as indicated for their underlying benign biliary pathology.

Bilioenteric continuity was reestablished by means of an RYHJ using a retrocolic Roux limb measuring 50–60 cm, taken approximately 35 cm distal to the duodenojejunal flexure. The Roux limb was anastomosed in an end-to-side manner to the transected hepatic duct using either a modified Blumgart single-layer interrupted technique or a single-layer continuous technique with 3-0 or 4-0 polyglactin (Vicryl) sutures, as depicted in Figures 1 to 4. No new intraoperative trans-anastomotic stents were used. In patients with preoperative percutaneous transhepatic biliary drainage, the catheter was retained as a stent and removed after clinical and radiological confirmation of anastomotic healing in the postoperative period. Operative details, including the type of RYHJ technique (interrupted or continuous), duration of surgery, intraoperative blood loss, and bile duct diameter, were noted.

Postoperatively, patients were monitored for early complications such as bile leak and bleeding. Late complications, including anastomotic stricture and recurrent cholangitis, were recorded during follow-up. Length of postoperative hospital stay, need for readmissions, reinterventions, and resurgeries were documented. Postoperative complications were graded using the Clavien–Dindo classification. Early complications were defined as those occurring

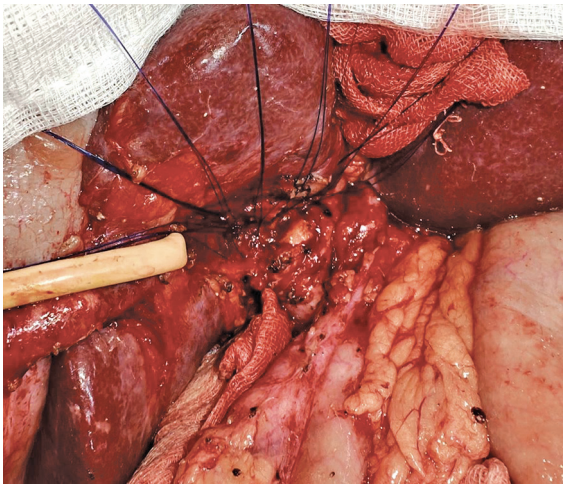

Fig. 1: External biliary fistula following post-cholecystectomy bile duct injury. A Foley's catheter is inserted into the fistula tract and hepatic duct, with stay sutures placed on the anterior wall of the hepatic duct (prior to fistula takedown)

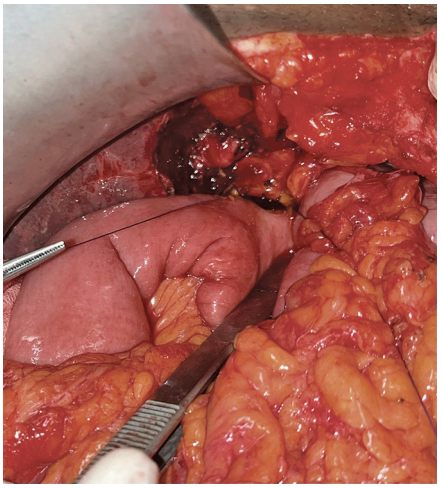

Fig. 3: Incomplete RYHJ with a completed posterior layer following extrahepatic bile duct excision in a patient with a type Ic choledochal cyst

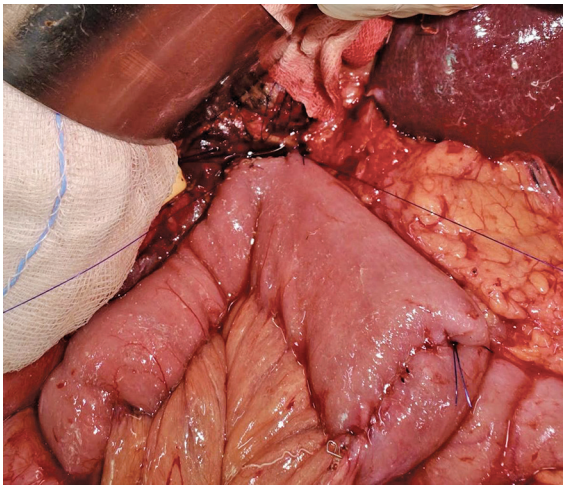

Fig. 2: Roux-en-Y hepaticojejunostomy between the hepatic duct and a retrocolic Roux limb of jejunum, fashioned 30 cm distal to the duodenojejunal flexure and brought through a window in the transverse mesocolon to the right of the middle colic vessels, following fistula takedown. The posterior layer is completed, and the anterior layer is incomplete

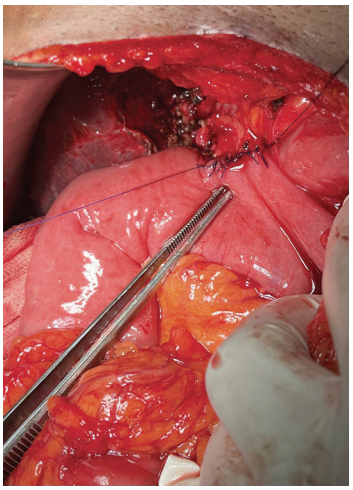

Fig. 4: Completed RYHJ (indicated by forceps) following extrahepatic bile duct excision in a patient with a type Ic choledochal cyst

within 30 postoperative days, and late complications as those occurring beyond 30 days. Bile leak and strictures were defined according to the International Study Group of Liver Surgery (ISGLS) criteria.

Long-term functional outcomes were assessed using the McDonald classification. Quality of life was evaluated using the World Health Organization Quality of Life–BREF (WHOQOL-BREF) questionnaire and categorized as good or poor outcomes based on trends in baseline and follow-up scores. Follow-up included clinical evaluation, liver function tests, relevant blood investigations, and imaging when clinically indicated to detect collections, strictures, or leaks.

The primary outcomes analyzed were perioperative morbidity, mortality, early and late postoperative complication rates, and long-term functional outcomes based on the McDonald classification. Secondary outcomes included QoL (WHOQOL-BREF). Potential risk factors for adverse outcomes included underlying biliary diagnosis, preoperative cholangitis, jaundice, prior biliary stenting, operative duration, intraoperative blood loss, anastomotic techniques, bile-duct leak rates, and stricture rates leading to delayed recovery, Readmissions, reinterventions, and resurgeries.

Statistical Analysis

Descriptive statistics were used to summarize demographic and clinical variables. Associations were analyzed using the chi-square test or Fisher's exact test when required. Correlations were evaluated using Spearman's rank correlation. A p-value < 0.05 was considered statistically significant. Data were analyzed using SPSS software version 25.

Results

Most patients were between 31 and 60 years (68.6%), with a slight female predominance (54.5%). Iatrogenic bile duct strictures were the most frequent diagnosis (34.7%), and most patients had

no comorbidities (76.9%). Preoperative jaundice was present in 44.6% of patients, and cholangitis in 12.4%, requiring preoperative stenting in 30.6%. Most patients had bile duct sizes of 1–2 cm, and the interrupted HJ technique was commonly used (82.6%), based on the intraoperative findings. Surgery typically lasted 4–6 hours (76%), with blood loss of less than 300 mL in 64.5% of cases. Early complications were low, with bile leak in 18.2% of patients and bleeding in 2.5%, and late complications occurred in 11.6% of patients. Hospital stay was less than 10 days in most patients (69.4%), and the readmission rate was 27.3%. Postoperative reinterventions were required in 19.8% of patients, and resurgery in 9.9%. Only 17.4% had major (grade III or more) Clavien–Dindo complications, and long-term outcomes were good, with 71.9% in McDonald grade A and 87.6% showing good or improved WHOQOL-BREF scores (Table 1).

There was no significant association between the type of HJ (interrupted vs continuous) and any postoperative outcome. Early complications, late strictures, Clavien–Dindo grades, McDonald functional grades, blood loss, hospital stay, readmission, need for postoperative interventions, resurgery rates, and WHOQOL-BREF scores were similar between both techniques, with all $p > 0.05$ (Table 2).

Table 1: Demographic and clinical profile

Parameters	*Category*	*N (%)*
Age (years)	<17	9 (7.4%)
	18–30	16 (13.2%)
	31–40	26 (21.5%)
	41–50	26 (21.5%)
	51–60	31 (25.6%)
	>61	13 (10.7%)
Sex	Female	66 (54.5%)
	Male	55 (45.5%)
Diagnosis	Iatrogenic bile duct strictures	42 (34.7%)
	Choledochal cyst	33 (27.3%)
	Choledocholithiasis	15 (12.4%)
	Hepatolithiasis	17 (14.0%)
	Mirizzi syndrome	11 (9.1%)
	Portal biliopathy	3 (2.5%)
Comorbidities	Diabetes	13 (10.7%)
	Hypertension	9 (7.4%)
	Both	6 (5.0%)
	Nil	93 (76.9%)
Jaundice	Yes	54 (44.6%)
	No	67 (55.4%)
Cholangitis	Yes	15 (12.4%)
	No	106 (87.6%)
Stenting	Yes	37 (30.6%)
	No	84 (69.4%)
Hypoalbuminemia	Yes	20 (16.5%)
	No	101 (83.5%)
Anemia	Yes	22 (18.2%)
	No	99 (81.8%)
Bile duct size (cm)	≤1	38 (31.4%)
	≤1.5	29 (24.0%)
	≤2	41 (33.9%)
	>2	13 (10.7%)
RYHJ technique	Interrupted	100 (82.6%)
	Continuous	21 (17.4%)
Duration of surgery (hours)	<4	15 (12.4%)
	4–6	92 (76.0%)
	>6	14 (11.6%)
Blood loss (mL)	<300	78 (64.5%)
	300–500	36 (29.8%)
	>500	7 (5.8%)
Early complications	Leak	22 (18.2%)
	No	96 (79.3%)
	Bleed	3 (2.5%)
Late complications	Stricture/cholangitis	14 (11.6%)
	No	107 (88.4%)
Hospital stays (days)	<10	84 (69.4%)
	10–30	30 (24.8%)
	> 30	7 (5.8%)
Readmission	Yes	33 (27.3%)
	No	88 (72.7%)
Postop intervention	PCD	10 (8.3%)
	PTBD	11 (9.1%)
	Embolization	3 (2.5%)
	None	97 (80.2%)
Resurgery	Yes	12 (9.9%)
	No	109 (90.1%)
Clavien–Dindo classification	No	63 (52.1%)
	Minor	37 (30.6%)
	Major	21 (17.4%)
McDonald classification	A	87 (71.9%)
	B	19 (15.7%)
	C	3 (2.5%)
	D	12 (9.9%)
WHOQOL-BREF	Good/improved scores	106 (87.6%)
	Poor/worsening scores	15 (12.4%)

Values are expressed as mean ± SD, median (IQR), or *n* (%), as appropriate. HJ, hepaticojejunostomy; RYHJ, Roux-en-Y hepaticojejunostomy

Age, sex, comorbidities, preoperative stenting, anemia, bile duct size, and anastomotic technique showed no significant association with early or late complications (all $p > 0.05$). Diagnosis showed no association with early complications ($p > 0.05$) but a significant association with late complications ($p = 0.046$). Jaundice, cholangitis, hypoalbuminemia, prolonged operative duration, and higher intraoperative blood loss were significantly associated

Table 2: Comparison of interrupted vs continuous HJ technique

		RYHJ		
Parameters	*Category*	*Interrupted*	*Continuous*	*p-value*
Early complications	Leak	17 (77.3%)	5 (22.7%)	0.576
	No	80 (83.3%)	16 (16.7%)	
	Bleed	3 (100%)	0	
Late complication	Stricture/cholangitis	11 (78.6%)	3 (21.4%)	0.669
	No	89 (83.2%)	18 (16.8%)	
Clavien–Dindo classification	No	54 (85.7%)	9 (14.3%)	0.63
	Minor	29 (78.4%)	8 (21.6%)	
	Major	17 (81%)	4 (19%)	
McDonald classification	A	74 (85.1%)	13 (14.9%)	0.669
	B	15 (78.9%)	4 (21.1%)	
	C	2 (66.7%)	1 (33.3%)	
	D	9 (75%)	3 (25%)	
Blood loss (mL)	<300	62 (79.5%)	16 (20.5%)	0.314
	300–500	31 (86.1%)	5 (13.9%)	
	>500	7 (100%)	0	
Hospital stays (days)	<10	69 (82.1%)	15 (17.9%)	0.617
	10–30	26 (86.7%)	4 (13.3%)	
	>30	5 (71.4%)	2 (28.6%)	
Readmission	Yes	26 (78.8%)	7 (21.2%)	0.493
	No	74 (84.1%)	14 (15.9%)	
Postoperative intervention	PCD	9 (90%)	1 (10%)	0.281
	PTBD	7 (63.6%)	4 (36.4%)	
	Embolization	3 (100%)	0	
	No	81 (83.5%)	16 (16.5%)	
Resurgery	Yes	10 (83.3%)	2 (16.7%)	0.947
	No	90 (82.6%)	19 (17.4%)	
WHOQOL-BREF	Good/improved	89 (84%)	17 (16%)	0.309
	Poor/worsening	11 (73.3%)	4 (26.7%)	

Values are expressed as mean ± SD or median (IQR). HJ, hepaticojejunostomy; RYHJ, Roux-en-Y hepaticojejunostomy

with early complications (all $p < 0.05$), while jaundice, cholangitis, and hypoalbuminemia were also significantly associated with late complications (all $p < 0.05$). McDonald classification showed an association with both early and late complications ($p < 0.0001$) (Tables 3 and 4).

Comorbidities, including diabetes and hypertension, showed no significant association with Clavien–Dindo grades. In contrast, jaundice and cholangitis showed a significant association, with higher proportions of major complications in affected patients. Stenting and hypoalbuminemia were also significantly associated with increased severity of complications. Anemia showed a modest but significant association with higher minor and major complication rates. The type of HJ technique showed no significant association with complication grades. However, longer operative duration and greater intraoperative blood loss were associated with increased severity of complications, particularly operations exceeding 6 hours and a blood loss >500 mL showed the highest rates of major complications.

Age, sex, stenting, anemia, bile duct size, and the type of HJ showed no significant association with McDonald outcomes or WHOQOL-BREF QoL scores. Diagnosis showed a significant association with McDonald classification, but not with QoL scores. Early leaks and late complications showed significant associations with both poorer McDonald grades and poorer WHOQOL-BREF scores. Hypoalbuminemia and jaundice were also significantly associated with worse McDonald outcomes. Longer hospital stay showed a significant association with declining McDonald grades. Readmission and resurgery were both associated with poorer WHOQOL-BREF outcomes (Table 5).

Diagnosis showed no significant association with early complications, as leak and bleed rates were comparable across groups. However, a significant association with late complications, with hepatolithiasis showing the highest late stricture/cholangitis rate (35.3%) (Table 6). Clavien–Dindo severity also varied significantly by diagnosis, with major complications more common in hepatolithiasis and portal biliopathy. Hospital stay did not differ significantly across diagnostic groups, although prolonged stays (>30 days) were more frequent in hepatolithiasis and portal biliopathy. Resurgery showed a significant association with diagnosis, occurring most frequently in hepatolithiasis (35.3%).

Table 3: Association of patient and perioperative variables with early and late complications

		Early complication				*Late complication*		
Variable	*Category*	*Leak*	*Bleed*	*No*	*p-value*	*Stricture/ Cholangitis*	*No*	*p-value*
Age-group (years)	<17	3 (33.3%)	0	6 (66.7%)	0.503	3 (33.3%)	6 (66.7%)	0.085
	18–30	0	1 (6.3%)	15 (93.8%)		1 (6.3%)	15 (93.8%)	
	31–40	6 (23.1%)	1 (3.8%)	19 (73.1%)		3 (11.5%)	23 (88.5%)	
	41–50	6 (23.1%)	1 (3.8%)	19 (73.1%)		1 (3.8%)	25 (96.2%)	
	51–60	6 (19.4%)	0	25 (80.6%)		6 (19.4%)	25 (80.6%)	
	>61	1 (7.7%)	0	12 (92.3%)		0	13 (100%)	
Sex	Female	13 (19.7%)	2 (3%)	51 (77.3%)	0.803	8 (12.1%)	58 (87.9%)	0.836
	Male	9 (16.4%)	1 (1.8%)	45 (81.8%)		6 (10.9%)	49 (89.1%)	
Diagnosis	Iatrogenic bile duct stricture	8 (19%)	2 (4.8%)	32 (76.2%)	0.068	4 (9.5%)	38 (90.5%)	0.046
	Choledochal cyst	6 (18.2%)	0	27 (81.8%)		2 (6.1%)	31 (93.9%)	
	Choledocholithiasis	1 (6.7%)	0	14 (93.3%)		1 (6.7%)	14 (93.3%)	
	Hepatolithiasis	4 (23.5%)	0	13 (76.5%)		6 (35.3%)	11 (64.7%)	
	Mirizzi syndrome	2 (18.2%)	0	9 (81.8%)		1 (9.1%)	10 (90.9%)	
	Portal biliopathy	1 (33.3%)	1 (33.3%)	1 (33.3%)		0	3 (100%)	
Comorbidities	Diabetes	1 (7.7%)	0	12 (92.3%)	0.7	4 (30.8%)	9 (69.2%)	0.082
	Hypertension	2 (22.2%)	0	7 (77.8%)		0	9 (100%)	
	Both	0	0	6 (100%)		0	6 (100%)	
	Nil	19 (20.4%)	3 (3.2%)	71 (76.3%)		10 (10.8%)	83 (89.2%)	
Jaundice	Yes	15 (27.8%)	2 (3.7%)	37 (68.5%)	0.031	12 (22.2%)	42 (77.8%)	0.001
	No	7 (10.4%)	1 (1.5%)	59 (88.1%)		2 (3%)	65 (97%)	
Cholangitis	Yes	8 (53.3%)	0	7 (46.7%)	0.001	7 (46.7%)	8 (53.3%)	<0.0001
	No	14 (13.2%)	3 (2.8%)	89 (84%)		7 (6.6%)	99 (93.4%)	
Stenting	Yes	10 (27%)	2 (5.4%)	25 (67.6%)	0.079	6 (16.2%)	31 (83.8%)	0.289
	No	12 (14.3%)	1 (1.2%)	71 (84.5%)		8 (9.5%)	76 (90.5%)	
Hypoalbuminemia	Yes	12 (60%)	0	8 (40%)	<0.0001	5 (25%)	15 (75%)	0.04
	No	10 (9.9%)	3 (3%)	88 (87.1%)		9 (8.9%)	92 (91.1%)	
Anemia	Yes	6 (27.3%)	1 (4.5%)	15 (68.2%)	0.349	3 (13.6%)	19 (86.4%)	0.738
	No	16 (16.2%)	2 (2%)	81 (81.8%)		11 (11.1%)	88 (88.9%)	
Bile duct size (cm)	≤1	8 (21.1%)	0	30 (78.9%)	0.616	8 (21.1%)	30 (78.9%)	0.121
	≤1.5	6 (20.7%)	2 (6.9%)	21 (72.4%)		3 (10.3%)	26 (89.7%)	
	≤2	6 (14.6%)	1 (2.4%)	34 (82.9%)		3 (7.3%)	38 (92.7%)	
	>2 cm	2 (15.4%)	0	11 (84.6%)		0	13 (100%)	
RYHJ technique	Interrupted	17 (17%)	3 (3%)	80 (80%)	0.576	11 (11%)	89 (89%)	0.669
	Continuous	5 (23.8%)	0	16 (76.2%)		3 (14.3%)	18 (85.7%)	
Duration of surgery (hours)	<4	2 (13.3%)	0	13 (86.7%)	0.002	1 (6.7%)	14 (93.3%)	0.011
	4–6	14 (15.2%)	1 (1.1%)	77 (83.7%)		8 (8.7%)	84 (91.3%)	
	>6	6 (42.9%)	2 (14.3%)	6 (42.9%)		5 (35.7%)	9 (64.3%)	
Blood loss (mL)	<300	11 (14.1%)	0	67 (85.9%)	<0.0001	6 (7.7%)	72 (92.3%)	0.133
	300–500	11 (30.6%)	1 (2.8%)	24 (66.7%)		6 (16.7%)	30 (83.3%)	
	>500	0	2 (28.6%)	5 (71.4%)		2 (28.6%)	5 (71.4%)	
McDonald classification	A	2 (2.3%)	2 (2.3%)	83 (95.4%)	<0.0001	0	87 (100%)	<0.0001
	B	13 (68.4%)	1 (5.3%)	5 (26.3%)		0	19 (100%)	
	C	2 (66.7%)	0	1 (33.3%)		3 (100%)	0	
	D	5 (41.7%)	0	7 (58.3%)		11 (91.7%)	1 (8.3%)	

Values are expressed as *n* (%). Complications graded according to the Clavien–Dindo classification

Table 4: Association of variables with Clavien–Dindo complication severity

		Clavien–Dindo classification			
Variable	*Category*	*No*	*Minor*	*Major*	*p-value*
Comorbidities	Diabetes	7 (53.8%)	4 (30.8%)	2 (15.4%)	0.349
	Hypertension	4 (44.4%)	5 (55.6%)	0	
	Both	5 (83.3%)	1 (16.7%)	0	
	Nil	47 (50.5%)	27 (29%)	19 (20.4%)	
Jaundice	Yes	19 (35.2%)	18 (33.3%)	17 (31.5%)	<0.0001
	No	44 (65.7%)	19 (28.4%)	4 (6%)	
Cholangitis	Yes	3 (20%)	4 (26.7%)	8 (53.3%)	<0.0001
	No	60 (56.6%)	33 (31.1%)	13 (12.3%)	
Stenting	Yes	14 (37.8%)	12 (32.4%)	11 (29.7%)	0.033
	No	49 (58.3%)	25 (29.8%)	10 (11.9%)	
Hypoalbuminemia	Yes	4 (20%)	7 (35%)	9 (45%)	<0.0001
	No	59 (58.4%)	30 (29.7%)	12 (11.9%)	
Anemia	Yes	6 (27.3%)	11 (50%)	5 (22.7%)	0.031
	No	57 (57.6%)	26 (26.3%)	16 (16.2%)	
RYHJ	Interrupted	54 (54%)	29 (29%)	17 (17%)	0.63
	Continuous	9 (42.9%)	8 (38.1%)	4 (19%)	
Duration of surgery (hours)	<4	8 (53.3%)	6 (40%)	1 (6.7%)	<0.0001
	4–6	52 (56.5%)	29 (31.5%)	11 (12%)	
	>6	3 (21.4%)	2 (14.3%)	9 (64.3%)	
Blood loss (mL)	<300	52 (66.7%)	18 (23.1%)	8 (10.3%)	<0.0001
	300–500	10 (27.8%)	17 (47.2%)	9 (25%)	
	>500	1 (14.3%)	2 (28.6%)	4 (57.1%)	

Values are expressed as *n* (%). Late complications were assessed during follow-up

Table 5: Association of variables with McDonald's functional outcome and QoL

		McDonald classification					*Quality of life (WHOQOL-BREF)*		
Variable	*Category*	*A*	*B*	*C*	*D*	*p-value*	*Good/ Improved*	*Poor/ Worsening*	*p-value*
Age-group	<17	5 (55.6%)	1 (11.1%)	1 (11.1%)	2 (22.2%)	0.234	6 (66.7%)	3 (33.3%)	0.095
	18–30	13 (81.3%)	2 (12.5%)	1 (6.3%)	0		15 (93.8%)	1 (6.3%)	
	31–40	16 (61.5%)	6 (23.1%)	1 (3.8%)	3 (11.5%)		22 (84.6%)	4 (15.4%)	
	41–50	19 (73.1%)	6 (23.1%)	0	1 (3.8%)		25 (96.2%)	1 (3.8%)	
	51–60	22 (71%)	3 (9.7%)	0	6 (19.4%)		25 (80.6%)	6 (19.4%)	
	>61	12 (92.3%)	1 (7.7%)	0	0		13 (100%)	0	
Sex	Female	45 (68.2%)	12 (18.2%)	2 (3%)	7 (10.6%)	0.778	57 (86.4%)	9 (13.6%)	0.65
	Male	42 (76.4%)	7 (12.7%)	1 (1.8%)	5 (9.1%)		49 (89.1%)	6 (10.9%)	
Diagnosis	Iatrogenic bile duct stricture	31 (73.8%)	7 (16.7%)	1 (2.4%)	3 (7.1%)	0.008	38 (90.5%)	4 (9.5%)	0.08
	Choledochal cyst	26 (78.8%)	4 (12.1%)	1 (3%)	2 (6.1%)		30 (90.9%)	3 (9.1%)	
	Choledocholithiasis	14 (93.3%)	0	0	1 (6.7%)		14 (93.3%)	1 (6.7%)	
	Hepatolithiasis	6 (35.3%)	5 (29.4%)	0	6 (35.3%)		11 (64.7%)	6 (35.3%)	
	Mirizzi syndrome	9 (81.8%)	1 (9.1%)	1 (9.1%)	0		10 (90.9%)	1 (9.1%)	
	Portal biliopathy	1 (33.3%)	2 (66.7%)	0	0		3 (100%)	0	
Stenting	Yes	22 (59.5%)	9 (24.3%)	1 (2.7%)	5 (13.5%)	0.224	31 (83.8%)	6 (16.2%)	0.397
	No	65 (77.4%)	10 (11.9%)	2 (2.4%)	7 (8.3%)		75 (89.3%)	9 (10.7%)	

(Contd...)

Table 5: *(Contd...)*

		McDonald classification					*Quality of life (WHOQOL-BREF)*		
Variable	*Category*	*A*	*B*	*C*	*D*	*p-value*	*Good/ Improved*	*Poor/ Worsening*	*p-value*
Early complications	Leak	2 (9.1%)	13 (59.1%)	2 (9.1%)	5 (22.7%)	<0.0001	15 (68.2%)	7 (31.8%)	0.009
	No	83 (86.5%)	5 (5.2%)	1 (1%)	7 (7.3%)		88 (91.7%)	8 (8.3%)	
	Bleed	2 (66.7%)	1 (33.3%)	0	0		3 (100%)	0	
Late complication	Yes	0	0	3 (21.4%)	11 (78.6%)	<0.0001	0	14 (100%)	<0.0001
	No	87 (81.3%)	19 (17.8%)	0	1 (0.9%)		106 (99.1%)	1 (0.9%)	
Bile duct size (cm)	≤1	24 (63.2%)	6 (15.8%)	1 (2.6%)	7 (18.4%)	0.741	–	–	–
	≤1.5	21 (72.4%)	5 (17.2%)	1 (3.4%)	2 (6.9%)		–	–	–
	≤2	31 (75.6%)	7 (17.1%)	1 (2.4%)	2 (4.9%)		–	–	–
	>2	11 (84.6%)	1 (7.7%)	0	1 (7.7%)		–	–	–
RYHJ technique	Interrupted	74 (74%)	15 (15%)	2 (2%)	9 (9%)	0.669	–	–	–
	Continuous	13 (61.9%)	4 (19%)	1 (4.8%)	3 (14.3%)		–	–	–
Hospital stays (days)	<10	78 (92.9%)	6 (7.1%)	0	0	<0.0001	–	–	–
	10–30	9 (30%)	11 (36.7%)	3 (10%)	7 (23.3%)		–	–	–
	>30	0	2 (28.6%)	0	5 (71.4%)		–	–	–
Readmission	–	–	–	–	–	–	18 (54.5%)	15 (45.5%)	<0.0001
Resurgery	–	–	–	–	–	–	0	12 (100%)	<0.0001

Values are expressed as *n* (%). Functional outcome assessed using the McDonald classification

Table 6: Association of diagnosis with complications and outcomes

		Diagnosis						
Variable	*Category*	*Iatrogenic bile duct stricture*	*Choledochal cyst*	*Choledocholithiasis*	*Hepatolithiasis*	*Mirizzi syndrome*	*Portal biliopathy*	*p-value*
Early complications	Leak	8 (19%)	6 (18.2%)	1 (6.7%)	4 (23.5%)	2 (18.2%)	1 (33.3%)	0.068
	No	32 (76.2%)	27 (81.8%)	14 (93.3%)	13 (76.5%)	9 (81.8%)	1 (33.3%)	
	Bleed	2 (4.8%)	0	0	0	0	1 (33.3%)	
Late complication	Stricture/ cholangitis	4 (9.5%)	2 (6.1%)	1 (6.7%)	6 (35.3%)	1 (9.1%)	0	0.046
	No	38 (90.5%)	31 (93.9%)	14 (93.3%)	11 (64.7%)	10 (90.9%)	3 (100%)	
Clavien–Dindo classification	No	10 (23.8%)	24 (72.7%)	12 (80%)	7 (41.2%)	9 (81.8%)	1 (33.3%)	<0.0001
	Minor	24 (57.1%)	3 (9.1%)	3 (20%)	7 (41.2%)	0	0	
	Major	8 (19%)	6 (18.2%)	0	3 (17.6%)	2 (18.2%)	2 (66.7%)	
Hospital stays (days)	<10	27 (64.3%)	27 (81.8%)	12 (80%)	10 (58.8%)	8 (72.7%)	0	0.097
	10–30	11 (26.2%)	5 (15.2%)	3 (20%)	5 (29.4%)	3 (27.3%)	3 (100%)	
	>30	4 (9.5%)	1 (3%)	0	2 (11.8%)	0	0	
Resurgery	Yes	3 (7.1%)	1 (3%)	1 (6.7%)	6 (35.3%)	1 (9.1%)	0	0.011
	No	39 (92.9%)	32 (97%)	14 (93.3%)	11 (64.7%)	10 (90.9%)	3 (100%)	

Values are expressed as *n* (%). *p*-value compares outcomes across diagnostic categories (Chi-square/Fisher's exact test)

Discussion

This study evaluated surgical, functional, and QoL outcomes following elective RYHJ for benign biliary disease. The results demonstrate low overall morbidity with favorable long-term functional recovery and QoL outcomes. No significant differences were observed between interrupted and continuous anastomotic suturing techniques. In contrast, postoperative morbidity was significantly associated with preoperative cholangitis, poor nutritional status, prolonged operative duration with increased blood loss, and underlying biliary pathology. Variations in outcomes reported across published studies are likely attributable to differences in patient characteristics, inflammatory burden, timing of referral, and surgical expertise.

This study population consisted mainly of middle-aged patients with a slight female predominance, with no major comorbidities and most commonly presenting with iatrogenic bile duct strictures, followed by choledochal cysts, hepatolithiasis,

choledocholithiasis, Mirizzi syndrome, and portal biliopathy, frequently complicated with biliary obstruction and cholangitis, and a portion of them requiring preoperative stenting. Interrupted HJ was the predominant anastomotic technique, and operative parameters were within expected ranges. Postoperative morbidity and reintervention rates were low, hospital stay was typically short, and long-term functional and QoL outcomes were favorable. In comparison, Booij et al. reported a median age of 46.3 years (IQR 36.5–62.3) with a higher female predominance of 67.3%.[10] Seifert et al. described an older cohort with median ages of 72 and 67 years and a near-equal sex distribution, in which most patients were classified as American Society of Anesthesiologists (ASA) III and had malignant disease, predominantly pancreatic carcinoma (48.8–56.4%) and extrahepatic bile duct carcinoma (19.5–23.1%). Preoperative biliary drainage and common bile duct stenting were required in more than half of these patients, with bile duct diameters ranging from 12 to 14 mm.[11] Saxena et al. analyzed a larger cohort of 556 patients with mean ages between 46 and 49 years, including both benign (53%) and malignant (47%) indications, and reported bile duct diameters of ≥8 mm in all cases.[12] Therefore, malignant cohorts in the literature tend to be older, with a higher burden of comorbidities and more complex disease profiles, which likely contributes to differences in complication patterns and postoperative recovery when compared with predominantly benign cohorts such as the present study.

In the present study, no significant difference was observed between interrupted and continuous HJ techniques. Early and late complication rates were comparable. The severity of complications, operative parameters, hospital stay, need for reintervention, functional outcomes, and QoL scores were similar between techniques. Saxena et al. reported overall morbidity rates of 38.6% in the continuous group and 42.7% in the interrupted group ($p = 0.47$). Bile leak was more frequent with interrupted sutures (10.2% vs 6.8%; $p = 0.04$). Thirty-day mortality rates were comparable (2.7–3.4%; $p = 0.42$), and median hospital stay was similar (9 vs 10 days; $p = 0.47$). Long-term anastomotic stricture occurred in 4.6% with no technique-related difference.[12] Ahmad et al. reported a 90-day morbidity of 51.7%, bile leak in 5.7%, and 90-day mortality of 2.3%. Long-term morbidity was 13.7%, with anastomotic stricture rate of 5.7% and a 10-year stricture-free survival of 95%.[2] A major strength of the present study is the uniform operative approach within a high-volume hepatobiliary center, supporting consistency in technique and follow-up evaluation.

Jaundice, cholangitis, hypoalbuminemia, prolonged operative duration, and increased blood loss were significantly associated with early complications in the present study. Demographic variables, comorbidities, anemia, bile duct size, preoperative stenting, and anastomotic technique showed no significant association. The McDonald classification correlated with postoperative outcomes. Booij et al. identified postoperative bile leakage, sepsis, and higher Clavien–Dindo grades as predictors of late stricture formation.[10] Seifert et al. reported no significant differences between continuous and interrupted techniques for bile leak, cholangitis, liver abscess, overall complications, or 30-day mortality.[11] Saxena et al. showed significantly shorter anastomosis time with continuous suturing (21.4 ± 11.2 vs 44.6 ± 20.3 minutes; $p < 0.001$).[12] The analysis was limited to univariate associations, and multivariable adjustment was not performed, which may allow residual confounding between clinical and operative factors.

Higher Clavien–Dindo grades in the present study were significantly associated with jaundice, cholangitis, hypoalbuminemia, preoperative stenting, anemia, prolonged operative duration, and increased blood loss. Comorbidities and anastomotic technique had no significant effect on complication severity. Booij et al. reported grade III–V complications in 14.6% of patients, associated with bile leak and sepsis.[10] Saxena et al. reported McDonald grade A outcomes in 94.1% of the continuous group and 87.4% of the interrupted group. Grade B outcomes were higher in the interrupted group (6.1% vs 1.2%; $p = 0.04$), while grade C outcomes were rare.[12] Otto et al. identified intra-abdominal infection, bile collection, failed primary repair, pre-reconstruction cholangitis, and female sex as independent predictors of poor long-term outcomes.[7]

Functional outcomes and QoL in the present study were mainly influenced by postoperative complications and the hospital course. Early bile leak, late complications, hypoalbuminemia, jaundice, prolonged hospital stay, readmission, and resurgery were associated with poorer McDonald grades and inferior QoL scores. Age, sex, bile duct size, anemia, stenting, and anastomotic technique had no significant impact. Ali et al. reported McDonald grade A outcomes in 67% of patients, with 87.5% achieving excellent or good results by Terblanche grading.[13] Otto et al. reported WHOQOL-BREF scores >60 across all domains, with better physical and psychological scores in clip-related obstruction.[7] These findings show the need to optimize cholangitis control, nutritional status, and perioperative parameters to reduce adverse outcomes. The absence of technique-related differences suggests that patient condition and inflammatory burden are more influential determinants of recovery than suturing method.

In the present study, the underlying biliary diagnosis emerged as a key determinant of late complications, severity of complications, and resurgery rates, while early postoperative complication rates remained comparable across diagnostic groups. Hepatolithiasis and portal biliopathy were associated with higher rates of late stricture, cholangitis, major Clavien–Dindo complications, and reinterventions. Hospital stay did not differ significantly between diagnostic groups. Otto et al. showed that the cause of referral influenced outcomes more than injury level, with clip-related obstruction showing the best results.[7] Kusano et al. reported worse long-term outcomes in hepatolithiasis.[14] Li et al. reported high rates of residual stones, recurrent cholangitis, and biliary complications after HJ in hepatolithiasis.[15]

Key strengths of this study include a comprehensive evaluation of perioperative variables, the use of validated and standardized systems for grading postoperative complications and functional outcomes, and the incorporation of patient-reported QoL assessment. The uniform surgical approach and consistent perioperative management within a specialized hepatobiliary unit further enhance the internal validity of the findings by minimizing technique-related variability. Although the single-center design limits generalizability, the results provide robust real-world data on isolated elective HJ for benign biliary disease. Future prospective, multicenter studies with longer follow-up and multivariable risk modeling are warranted to refine risk stratification, optimize preoperative optimization strategies, and further improve outcomes in complex biliary reconstruction.

Conclusion

Roux-en-Y HJ remains an effective reconstructive procedure for benign biliary pathologies, achieving good long-term functional

recovery and QoL when performed electively in specialized centers. The choice between interrupted and continuous anastomotic suturing does not significantly affect perioperative morbidity, late stricture formation, or patient-reported outcomes. The postoperative outcomes are predominantly influenced by preoperative biliary sepsis, jaundice, nutritional status, and intraoperative factors such as operative duration and blood loss. These findings highlight the importance of careful patient selection, preoperative optimization, and surgical expertise over technical variations in anastomotic suturing. Future studies should include multicenter, prospective designs with larger sample sizes to improve generalizability and allow robust evaluation of factors influencing long-term functional and QoL outcomes following elective RYHJ.

Limitations

This study is limited by its single-center, observational design, which may restrict the generalizability of the findings. The absence of randomization introduces the potential for selection bias, and unmeasured confounding factors may have influenced outcomes. Functional and QoL assessments, although performed using validated instruments, may be subject to response bias. Larger, multicenter prospective studies are required to confirm these findings and improve external validity.

Clinical Significance

In patients undergoing RYHJ for benign biliary diseases, postoperative outcomes and long-term QoL are influenced predominantly by patient- and disease-related characteristics rather than the suturing technique used for anastomosis. The findings suggest that technical variations in anastomotic suturing have a limited impact on functional and patient-reported outcomes when surgery is performed electively in specialized centers. Emphasis on appropriate patient selection, preoperative optimization, and meticulous perioperative management may yield better clinical benefit than modifications in suturing technique alone.

Authors' Contribution

PSN contributed to study conception, data acquisition and analysis, and manuscript drafting. AK contributed to study design, surgical supervision, data interpretation, and critical revision. PR contributed to operative management and outcome assessment. SC provided overall supervision, final manuscript approval, and took responsibility for the integrity of the work.

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Ethical Approval

Institutional Ethics Committee (IEC) clearance was obtained prior to commencement of the study (IEC no. MMC/Approval/05072024).

References

1. Marichez A, Adam J-P, Laurent C, et al. Hepaticojejunostomy for bile duct injury: State of the art. Langenbecks Arch Surg 2023;408:107. DOI: 10.1007/s00423-023-02818-3.
2. Ahmad H, Zia HH, Salih M, et al. Outcomes of hepaticojejunostomy for post-cholecystectomy bile duct injury. J Int Med Res 2023;51:3000605231162444. DOI: 10.1177/03000605231162444.
3. Sahoo MR, Ali MS, Sarthak S, et al. Laparoscopic hepaticojejunostomy for benign biliary stricture: A case series of 16 patients at a tertiary care centre in India. J Minim Access Surg 2022;18:20–24. DOI: 10.4103/jmas.JMAS_223_20.
4. Dimou FM, Adhikari D, Mehta HB, et al. Incidence of hepaticojejunostomy stricture after hepaticojejunostomy. Surgery 2016;160:691–698. DOI: 10.1016/j.surg.2016.05.021.
5. Halle-Smith JM, Hall LA, Mirza DF, et al. Risk factors for anastomotic stricture after hepaticojejunostomy for bile duct injury: A systematic review and meta-analysis. Surgery 2021;170:1310–1316. DOI: 10.1016/j.surg.2021.05.015.
6. Bustos R, Fernandes E, Mangano A, et al. Robotic hepaticojejunostomy: surgical technique and risk factor analysis for anastomotic leak and stenosis. HPB (Oxford) 2020;22:1442–1449. DOI: 10.1016/j.hpb.2020.02.007.
7. Otto W, Sierdziński J, Smaga J, et al. Long-term effects and quality of life following definitive bile duct reconstruction. Medicine (Baltimore) 2018;97:e12684. DOI: 10.1097/MD.0000000000012684.
8. Sturesson C, Hemmingsson O, Månsson C, et al. Quality-of-life after bile duct injury repaired by hepaticojejunostomy: A national cohort study. Scand J Gastroenterol 2020;55:1087–1092. DOI: 10.1080/00365521.2020.1800076.
9. AbdelRafee A, El-Shobari M, Askar W, et al. Long-term follow-up of 120 patients after hepaticojejunostomy for treatment of post-cholecystectomy bile duct injuries: A retrospective cohort study. Int J Surg 2015;18:205–210. DOI: 10.1016/j.ijsu.2015.05.004.
10. Booij KAC, Coelen RJ, de Reuver PR, et al. Long-term follow-up and risk factors for strictures after hepaticojejunostomy for bile duct injury: An analysis of surgical and percutaneous treatment in a tertiary center. Surgery 2018;163:1121–1127. DOI: 10.1016/j.surg.2018.01.003.
11. Seifert L, von Renesse J, Seifert AM, et al. Interrupted versus continuous suture technique for biliary-enteric anastomosis: Randomized clinical trial. BJS Open 2023;7. DOI: 10.1093/bjsopen/zrac163.
12. Saxena R, Ghosh NK, Galodha S. Economics and safety of continuous and interrupted suture hepaticojejunostomy: An audit of 556 surgeries. Ann Hepatobiliary Pancreat Surg 2021;25:472–476. DOI: 10.14701/ahbps.2021.25.4.472.
13. Ali MM, Mohamed MK, Mansour AM, et al. Outcomes of reconstructive hepaticojejunostomy for postcholecystectomy bile-duct injuries. Egypt J Surg 2021;40:1469–1475. DOI: 10.4103/ejs.ejs_266_21.
14. Kusano T, Isa TT, Muto Y, et al. Long-term results of hepaticojejunostomy for hepatolithiasis. Am Surg 2001;67:442–446. PMID: 11379645.
15. Li S-Q, Liang L-J, Peng B-G, et al. Hepaticojejunostomy for hepatolithiasis: A critical appraisal. World J Gastroenterol 2006;12:4170–4174. DOI: 10.3748/wjg.v12.i26.4170.