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CLINICAL INVESTIGATION BILIARY

Utilization of a Modified Roux-en-Y Anastomosis as an Access point for Percutaneous Transjejunal Cholangioplasty of Recurrent Biliary Strictures

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Abstract

Introduction Biliary duct injuries pose a significant management challenge due to the propensity for recurrent biliary strictures. Development of a modified Roux-en-Y hepaticojejunostomy known as a Hutson–Russell Pouch (HRP) provides a point of entry for repetitive access to the biliary tree. We aim to highlight the effectiveness of using the HRP as an access point for the long-term management of anastomotic and distal biliary strictures, thereby showcasing the value in potential widespread adoption of this modification to a standard surgical procedure.

Materials and methods IRB-approved retrospective study of 36 patients (10 M, 26 F; mean age 55.19 ± 13.94; 15–83) underwent a total of 110 transjejunal cholangiograms. Indications for cholangiogram included cholangitis (n = 38), surveillance (n = 36), and elevated liver enzymes (n = 36). Technical success was defined by the ability to access and intervene in the biliary tree via HRP access. In case of stenosis, the ability to successfully dilate (< 30%) residual stenosis was considered a technically successful procedure. Clinical success was defined by normalization of the liver function tests or resolution of cholangitis.

Results Technical success was achieved in 83/110 (75.45%) of the cases, and clinical success was achieved in 102/110 (98.2%). Transhepatic access was needed in 27/110 (24.5%) of the cases. Interventions performed included balloon cholangioplasty in 104/110 (94.5%), biliary stone removal in 2/110 (1.8%), biliary stent placement in 2/110 (1.8%), and biliary drain placement in 4/110 (3.6%). There were a total of 9/110 complications (8.2%).

Conclusion The HRP was an effective access point in the management of recurrent benign biliary strictures in this cohort.

Keywords Hutson–russell pouch · Modified Roux-en-Y hepaticojejunostomy · Transjejunal cholangiogram · Cholangioplasty · Percutaneous transhepatic cholangiogram · Benign biliary strictures

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Introduction

Biliary duct injuries pose a significant management challenge due to the propensity for recurrent biliary strictures leading to obstruction and/or cholangitis. It has been shown that even with prompt surgical repair of a bile duct injury, the rate of stricture formation at the anastomosis is up to 12.5% and, depending on the nature of injury, stricture formation also occurs in the remainder of the biliary tree [1–3]. These injuries and their recurrent nature necessitate repeated access to the biliary tree for the relief of

obstruction and for cholangioplasty. Patients suffering from iatrogenic injuries (from laparoscopic cholecystectomy or liver transplant) comprise the majority of the global population in need of frequent dilatation of biliary strictures. One study demonstrated that of patients who underwent hepatobiliary surgery, only 8% required no follow-up diagnostic testing or intervention postoperatively. Another reported the incidence of biliary stricture after living donor liver transplant to be approximately 30% [4–6].

A modified Roux-En-Y hepaticojejunostomy or choledochojejunostomy (biliary-enteric anastomosis with either the hepatic duct or common bile duct, respectively) with a blind-ending jejunal loop also known as a Hutson–Russell pouch (HRP) provides a point of entry for repetitive, simple access to the biliary tree without the need for multiple transhepatic accesses [7–9]. The HRP creation involves only minimal modification of the standard surgical technique of Roux-En-Y hepaticojejunostomy and can be easily and quickly created at the time of the repair of the biliary duct injury. The HRP allows for retrograde transjejunal cannulation of the biliary tree and provides a conduit for subsequent interventions. Using the HRP as an access point allows for treatment of multisegmental biliary disease without the need for multiple access points. Although this technique was introduced in the 1980s, it is rarely practiced and has not had widespread adoption.

The aim of this study is to highlight the effectiveness of using the Hutson–Russell pouch as a simple and minimally invasive access point to the biliary tree, and stress its utility in being repeatedly and advantageously used in the long-term management of anastomotic and distal biliary strictures. We hope to demonstrate the value of the HRP in the long-term management of, and in improving outcomes of patients with biliary injuries in order to promote potential global adoption of this simple modification to a standard surgical procedure.

Materials and methods

IRB approval was obtained for this single-center, retrospective study of 36 patients (26 F, 10 M; mean age 55.19 ± 13.94; range 15–83) between 2007 and 2018 who underwent a total of 110 transjejunal cholangiograms for the management of recurrent benign biliary strictures. Five fellowship-trained interventional radiologists with experience ranging from 3 to 15 years performed the transjejunal cholangiograms. All patients who were being treated for benign biliary strictures via an HRP were considered for the study. Accessing the HRP for retrograde biliary access was performed in all cases. Percutaneous transhepatic cholangiogram (PTC) was performed in some cases to aid the interventions via HRP or in those cases where the biliary system could not be accessed via the HRP loop.

All data were obtained from the electronic medical record (EMR) and PACS. Parameters recorded included demographics, the cause of initial bile duct injury, type of biliary-enteric anastomosis, liver function tests (LFTs), indication for access, type of intervention(s) performed, and the use of transhepatic access. HRP access and cholangioplasty were performed for patients with evidence of biliary obstruction (elevated bilirubin/liver function tests) and/or clinical evidence of cholangitis. Select patients who had history of recurrent interventions were scheduled for routine surveillance and intervention at fixed intervals, typically at 6 months. Surveillance was performed with ultrasound, and if findings showed evidence of some biliary obstruction, then cholangiography was performed. Any operative or postoperative complications were recorded according to the Cardiovascular and Interventional Radiological society of Europe (CIRSE) Classifications. Acute complications were recorded during the procedure, and postoperative records were reviewed for delayed complications. Technical success was defined by the ability to access and intervene in the biliary tree via the HRP access. In cases of stenosis, the ability to successfully dilate (< 30%) residual stenosis was considered technically successful. Clinical success was defined by improved biliary drainage as evidenced by normalization of LFTs or a resolution of cholangitis. The duration of maintenance of patency of the biliary ducts as evidenced by lack of elevation of liver function tests/absence of cholangitis was also another outcome that was measured.

Statistical analysis was performed using IBM-SPSS software. Descriptive statistics were performed on patient demographics to determine means and standard deviations. Significance testing was done using Chi-square test for categorical variables and *T* test for continuous variables.

Technique

Hutson–Russell pouch creation involves a minimal modification of the standard surgical technique of Roux-en-Y hepaticojejunostomy. The modification is characterized by creation of a blind-ended afferent loop of the jejunum close to the biliary-enteric anastomosis. At the time of surgery, this afferent limb is sutured to the anterior abdominal wall and this attachment is marked by metallic clips. The length of this blind-ended loop is between 5 and 15 cm, and it is placed in a non-tortuous fashion. Typically, the apex of the loop is where the biliary-enteric anastomosis is located. This is identified by contrast injection in a retrograde fashion and probing by the catheter and glide wire combination [7] (Fig. 1).

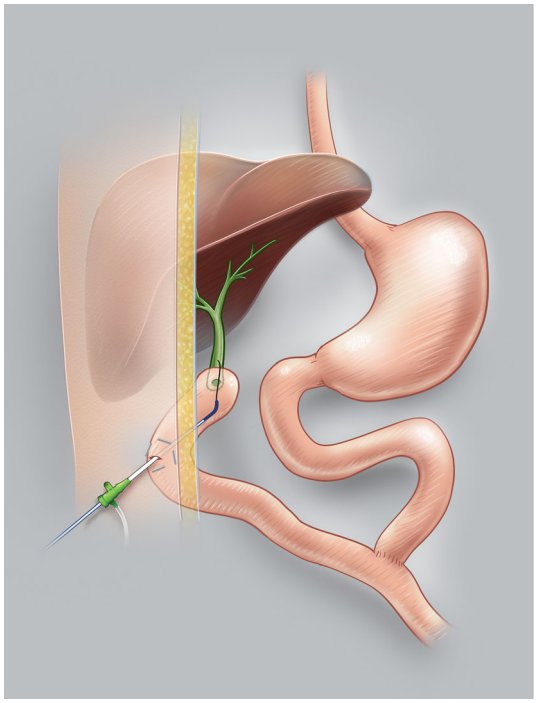

Fig. 1 Image depicting a Hutson–Russell pouch being accessed for retrograde transjejunal cholangiogram (Artist Robert Abrahams DO-Co-author)

Access and interventional procedures are done under general anesthesia or conscious sedation. The jejunal loop of the Hutson–Russell pouch is identified using fluoroscopy. The HRP is then accessed with an AccuStick (Boston Scientific, Marlborough, MA) needle under fluoroscopy with or without ultrasound guidance. Once contrast injection confirms intraluminal position of the needle, a 0.018″ microwire is passed into the bowel. After a series of exchanges and dilatation, an appropriately sized vascular sheath (e.g., 6 Fr) is introduced into the jejunal lumen. Next, using an angled tip catheter and Glidewire (Terumo Corporation, Tokyo, Japan) combination, the biliary anastomosis is accessed in a retrograde fashion for cholangiography (Fig. 1). Based on the cholangiogram findings, the strictures are then dilated with appropriately sized balloons. At the end of the procedure, the vascular sheath is removed and a sterile dressing is applied at the site of access. Patients are discharged home the same day after a varying period of observation (Figs. 2, 3).

Results

All patients underwent hepatobiliary surgery with HRP creation prior to cholangiogram. Indications for hepatobiliary surgery include common bile duct injury during cholecystectomy ($n = 19$), choledochal cyst excision ($n = 3$), proximal sclerosing cholangitis (PSC) ($n = 3$),

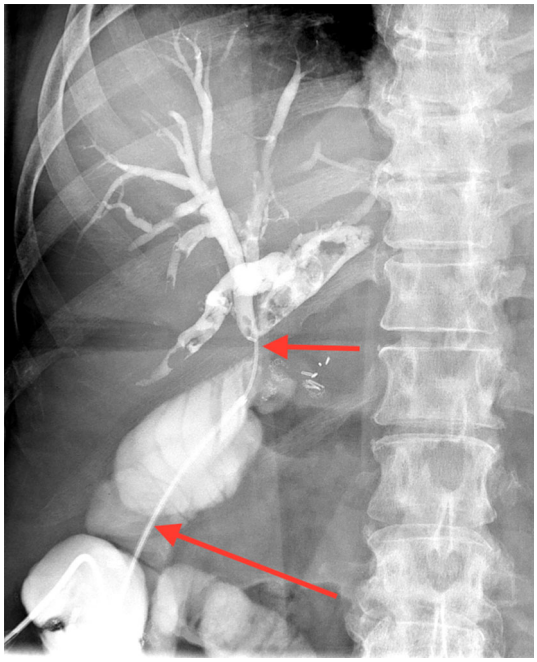

Fig. 2 Retrograde transjejunal cholangiogram via HRP access showing dilated left and right biliary ducts. Left ducts show significant amount of debris. Long arrow denotes the percutaneous sheath via the HRP loop. Short arrow denotes the diagnostic catheter traversing the stenotic choledochojejunal anastomosis

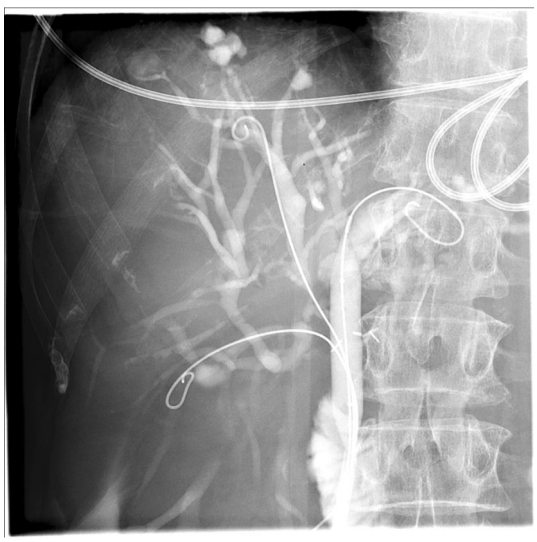

Fig. 3 Multiple biliary ducts are selected using a single access through the HRP, and balloon cholangioplasty is performed

Caroli's disease ($n = 1$), recurrent strictures following Whipple procedure ($n = 1$), transplant complications ($n = 2$), biliary lesion excision with biliary reconstruction ($n = 6$), and neurofibroma resection with biliary reconstruction ($n = 1$). Anatomy of the HRP included 26 patients with a hepaticojejunostomy and 10 with choledochojejunostomy. Each patient underwent an average of 3.17 (SD 4.15 range 1–20) procedures. Seventeen patients had

multiple procedures. Thirty-eight procedures were performed for cholangitis, 36 were for surveillance, and 36 were for biliary obstruction with elevated LFTs. Mean total follow-up duration was 1112.6 days (SD 1057, range 7–2551). Mean time interval in days between procedures for patients ($n = 17$) who underwent multiple procedures was 278.4 ± 163.5 (range 2.3–424.2) (Table 1).

Biliary tree access and interventions were exclusively performed via the HRP access in 83/110 (75.45%) of procedures, which denotes the technical success rate. In 27 patients, transhepatic access was used during the procedure. In 10 of these cases, biliary access and interventions were performed via HRP; however, additional transhepatic access was obtained to establish a through-and-through access by snaring the wire entering the biliary tree from the HRP to the outside. This maneuver was necessary due to the tight nature of the biliary strictures in these cases. In another 5 cases, the biliary tree could not be accessed in a retrograde fashion from HRP and transhepatic access was obtained to pass a wire into the jejunum. This wire was then snared to the outside via HRP to establish through-and-through access.

In 3/12 of the other technical failures, the appropriate HRP loop could not be identified by fluoroscopy due to the redundancy of loops and no transjejunal access was used. In the other 9/12 of these cases, the correct efferent loop could not be identified and PTC was done with contrast injection in order to identify the correct loop for transjejunal access. In these cases also, once the correct loop was identified, the access and intervention were performed via the HRP. Among the 27 cases of technical failures, transjejunal access was able to be utilized for interventions in 24/27 of the cases with the aid of PTC. Altogether, 107/110 patients had their biliary interventions via the HRP access. In all technically successful cases where stenosis was present, operators were able to successfully dilate to $< 30\%$ residual stenosis.

Clinical success was achieved in 102/110 (92.7%) of procedures. In the 8 cases of clinical failure, internal drainage of the biliary tree was not maintained due to inability to access certain parts of the biliary system through both PTC and transjejunal access. In all the cases performed for cholangitis and elevated liver function tests, the treatment was successful in resolving cholangitis and LFTs were normalized.

Interventions performed included balloon cholangioplasty in 104/110 (94.5%) cases. Biliary stone and sludge removal was performed using a compliant balloon catheter in 2/110 (1.8%) cases. Biliary stent placement was performed in 2/110 (1.8%) cases, and biliary drain placement was done in 4/110 (3.6%) cases. Of 110, 67 (60.9%) cases were performed on an outpatient basis.

There was no procedure-related mortality in this study. There were a total of 9 complications that occurred in 110 cases (8.2%). There were 6 grade 3 complications. Three were postoperative sepsis and bacteremia, which required extended inpatient stay and antibiotics. The fourth grade 3 complication was a venous hemorrhage, which was managed conservatively. The fifth grade 3 complication and the only access-related complication was the development of an abscess at the jejunal access site. The last grade 3 complication was a biliary leak which occurred in a patient who suffered a bile leak after an extended left hepatectomy for a cystic tumor in the left lobe of the liver. Leak

Table 1 Study population characteristics

Indications for HRP creation	Biliary duct injury during laparoscopic cholecystectomy($n = 19$)
	Choledochal cyst resection with reconstruction ($n = 3$)
	Proximal sclerosing cholangitis ($n = 3$)
	Caroli's disease ($n = 1$)
	Recurrent strictures following Whipple procedure ($n = 1$)
	Biliary lesion excision with biliary reconstruction ($n = 6$)
	Neurofibroma resection with biliary reconstruction ($n = 1$)
	Transplant complications ($n = 2$)
Type of biliary-enteric anastomosis	Hepaticojejunostomy ($n = 26$)
	Choledochojejunostomy ($n = 10$)
Indications for transjejunal cholangiogram	Clinical symptoms concerning for cholangitis ($n = 38$)
	Biliary obstruction with elevated LFTs ($n = 36$)
	Surveillance ($n = 36$)
Mean number of procedures per patient	3.17 ± 4.15 (1–20)
Mean total follow-up (days)	1112.6 ± 1057 (7–2551)
Mean number of days between procedures	278.4 ± 163.5 (2.3–424.2)

occurred during cholangioplasty of a tight anastomotic stricture and was managed with a biliary drainage catheter. There were no long-term sequelae of any of the major complications. There were 3 grade 2 complications which included postoperative fever, urinary retention, and 1 episode of biliary leak. This episode occurred while attempting to cross a tight stricture. This patient was managed conservatively and discharged that same day with no long-term sequelae. There were no complications directly associated with the creation of the loop.

Discussion

Approximately 95% of benign biliary injuries are secondary to biliary tract surgery, and 80% of these are associated with cholecystectomy or orthotopic liver transplantation [10, 11]. Both vascular and nonvascular iatrogenic injuries to the hepatobiliary system can be debilitating for patients both in the short and long terms. These injuries are unequivocally associated with significant morbidity and mortality, reduced long-term survival, and decreased quality of life [12].

In our cohort, 32/36 (88.9%) patients suffered complications from iatrogenic injuries and underwent biliary reconstruction. A prior study reported a stricture rate of 11% at a median of 13 months after biliary reconstructive surgery [13]. In a retrospective long-term follow-up of patients who underwent hepaticojejunostomy, 11.6% developed anastomotic stricture and 14.2% developed recurrent episodes of cholangitis [2]. Even with percutaneous treatment, rates of long-term patency vary in the literature between 33 and 90% [14, 15]. Due to the propensity of these lesions to recur, it becomes a difficult disease that requires a multidisciplinary approach to manage. Endoscopic retrograde cholangiopancreatography (ERCP) (the treatment of choice for biliary obstruction) is difficult in patients with altered biliary anatomy and Roux-en-Y anastomosis.

Dr. Duane Hutson and Dr. Edward Russell noted the high rate of recurrence in these strictures and developed a surgical modification which would later be known as Hutson–Russell Pouch (HRP) which aids in the management of these patients [7]. The blind-ended loop of jejunum which can be identified on fluoroscopy acts as an easy percutaneous entry point for transjejunal cholangiography and subsequent interventions. Hutson et al. [9] showed in a study looking at 30 patients over a 13-year period that benign biliary strictures could be effectively managed through the afferent limb of the HRP.

PTC (the standard treatment for treating biliary obstruction) is challenging in these patients as they can have non-dilated biliary systems (especially in the peripheral ducts) from sclerosing cholangitis due to recurrent infections. Additionally, multiple accesses may be needed to treat the disease in right and left ducts in these patients. In patients who undergo repeated transhepatic access, there is a risk of damage to the hepatic vasculature. Adopting the HRP and approaching the biliary system using a retrograde transjejunal approach will eliminate many of these difficulties and allows for the procedure to be done on an outpatient basis. This method would additionally alleviate difficulty in accessing patients with non-dilated peripheral ducts which can be seen commonly in patients with PSC. Finally, the transjejunal approach allows for the treatment of multifocal and segmental strictures using only the one access point.

In this study, operators were able to access the biliary tree through the HRP in 102/110 (92.7%) of the cases. In 19 of those 102 cases, PTC was needed to help facilitate transjejunal access which was then used to treat the biliary strictures. These failures occurred in 7 patients, and 5 of these patients had subsequent transjejunal cholangiograms which were successful when performed by different operators, suggesting operator variability. Another major advantage of this approach is that only 4/110 (3.6%) cases needed the placement of an external biliary drainage catheter for management. The major complication rate of 5/110 (4.5%) was higher than the reported complication rate of 2% for PTC; however, the patient population with HRP access have more complex disease and anatomy compared to that of patients undergoing standard PTC. Two out of three of the cases of sepsis postoperatively occurred in the same patient, and this patient presented for both procedures with symptoms concerning for cholangitis. In one of those procedures, cultures taken of the biliary duct yielded *Pseudomonas aeruginosa*. Importantly, accessing the HRP may be done on an outpatient basis, and in our study 67/110 (60.9%) of the cases were performed outpatient.

Due to collaborative efforts between interventionalists and surgeons at our institution, patients suffering from the sequelae of benign biliary strictures have an option for minimally invasive management. With that in mind, planning and communication between these departments are paramount to optimize treatment. At our institution, patients underwent transjejunal cholangiograms approximately 6 weeks following surgery, and future follow-up schedules were based on the findings from the initial cholangiogram. Typically, we aim for 6-month interval follow-up for cholangiography through the HRP followed by decompression with cholangioplasty if necessary.

The limitations of our study are consistent with those inherent in all retrospective studies, including missed data from incomplete records. Other limitations of the study were the small sample size, varied intervals between

procedures, heterogeneous follow-up duration and the heterogeneous nature of our cohort in terms of location of biliary strictures, age, and sex.

Conclusion

The complexity of management of iatrogenic biliary injuries necessitates a multidisciplinary approach to these cases. The Hutson–Russell pouch is an ideal solution as it involves only a minor modification to a widely utilized surgery for this indication that will make the future percutaneous management of strictures easier and more efficient. Interdisciplinary collaboration and adoption of the HRP technique will potentially improve the management of these debilitating biliary injuries.

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Compliance with Ethical Standards

Conflict of interest The authors declare they have no conflicts of interest.

Ethical Approval This study has obtained IRB approval from the University of Miami/Jackson Memorial Hospital, and the need for informed consent was waived.

Informed Consent Consent for publication was obtained for every individual person's data included in this study.

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