

Review

Future-Proof Biliary Reconstruction: Strategies to Facilitate Endoscopic Access After Hepaticojejunostomy

Motoyasu Tabuchi, Teppei Tokumaru, Sunao Uemura, Shuta Tamura and Takehiro Okabayashi * 

Department of Gastroenterological Surgery, Kochi Health Sciences Center, Kochi 781-855, Japan; motoyasun0610@gmail.com (M.T.); teppei.1090@gmail.com (T.T.); snatchuemura@gmail.com (S.U.); tamushu1212@gmail.com (S.T.)

* Correspondence: takehiro_okabayashi@khsc.or.jp; Tel.: +81-88-837-3000; Fax: +81-88-837-6766

Highlights

What are the main findings?

- Conventional Roux-en-Y hepaticojejunostomy may limit future endoscopic access despite advances in biliary intervention.
- Future Access Biliary Reconstruction (FABR) is proposed as a conceptual access-oriented strategy to preserve lifelong therapeutic accessibility.

What are the implications of the main findings?

- Incorporating future endoscopic accessibility into the initial reconstructive design may improve the long-term management of selected high-risk patients.
- Prospective multicenter studies are required to validate the safety, feasibility, and clinical value of FABR before routine clinical application.

Abstract

Background and Aims: Benign hepaticojejunostomy stricture (HJS) remains a challenging long-term complication after major hepatobiliary surgery. Although advanced endoscopic and interventional modalities have improved clinical outcomes, successful management is heavily constrained by anastomotic accessibility, particularly in altered post-hepatectomy anatomy. This review evaluates the clinical burden and anatomical barriers of conventional Roux-en-Y reconstruction and introduces “future-proof” biliary reconstruction strategies aimed at preserving lifelong therapeutic access. **Methods:** A comprehensive literature review was conducted to synthesize current evidence regarding the epidemiology, risk factors, and clinical consequences of benign HJS. We analyzed the technical limitations of contemporary interventions and critically reviewed the historical evolution of access-oriented surgical modifications, including access loops and modified enteric configurations. This narrative review was conducted through a structured search of PubMed, Scopus, and Web of Science for studies published between January 2000 and March 2026. Search terms included “hepaticojejunostomy”, “benign hepaticojejunostomy stricture”, “Roux-en-Y”, “balloon enteroscopy”, “EUS-guided biliary drainage”, “PTBD”, “access loop”, “jejunoduodenostomy”, and “biliary reconstruction”. Original articles, systematic reviews, meta-analyses, and relevant guideline papers published in English were included. Conference abstracts, editorials, and articles lacking sufficient clinical information were excluded. **Results:** Anatomical factors—such as excessive Roux limb length ($> 50\text{--}70\text{ cm}$), dense postoperative adhesions, sharp intestinal angulations, and complex multi-ductal hilar reconstructions—represent the primary drivers of endoscopic failure. Conventional reactive approaches address these barriers only after complications manifest, severely



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impacting patient quality of life and increasing healthcare utilization. Conversely, access-oriented strategies proactively incorporate long-term accessibility into initial operative planning. Specifically, Future Access Biliary Reconstruction (FABR)—utilizing a side-to-side jejunoduodenostomy between the elevated jejunal limb and the second portion of the duodenum—creates a direct, permanent route to the biliary limb, permitting rapid and reliable intervention via standard upper gastrointestinal endoscopy without compromising the primary hepaticojejunostomy. **Conclusions:** Future-proof biliary reconstruction represents a pivotal paradigm shift in hepatobiliary surgery, transitioning from purely functional restoration to proactive, lifelong disease management. Incorporating FABR during the index operation may eliminate anatomical barriers before they arise, potentially reducing reliance on invasive percutaneous interventions or high-risk surgical revisions. Prospective multicenter studies are warranted to validate its long-term safety, clinical efficacy, and optimal selection criteria.

Keywords: hepaticojejunostomy; benign biliary stricture; cholangitis; biliary reconstruction; endoscopic intervention; Roux-en-Y reconstruction; jejunoduodenostomy; Future Access Biliary Reconstruction; future-proof surgery; hepatobiliary surgery

1. Introduction

Advances in hepatobiliary surgery and perioperative care have significantly improved long-term survival for patients undergoing major liver resection and biliary reconstruction for malignancies [1,2]. However, benign hepaticojejunostomy stricture (HJS) remains a challenging late complication, with reported incidences ranging from 5% to 30% [3–5]. HJS can manifest months or years postoperatively, causing recurrent cholangitis, intrahepatic lithiasis, and progressive liver function deterioration [6,7]. This recurrent inflammation often accelerates fibrotic narrowing, creating a vicious cycle that complicates management.

While endoscopic intervention is the preferred first-line treatment, its success depends heavily on postoperative anatomy. Balloon-assisted enteroscopy has expanded the feasibility of endoscopic retrograde cholangiography in surgically altered anatomies [8]. However, accessing the hepaticojejunostomy after major hepatectomy with Roux-en-Y reconstruction remains technically demanding due to long afferent limbs, adhesions, and sharp angulations [8,9]. When endoscopy fails, invasive alternatives like percutaneous transhepatic biliary drainage (PTBD), endoscopic ultrasound-guided drainage, or surgical revision are required [10,11]. These procedures carry substantial risks, reduce quality of life, and increase healthcare costs.

Consequently, preventing difficult biliary access has become a critical management consideration. While traditional reconstruction focused primarily on immediate functional success and preventing bile leakage, the increasing population of long-term survivors necessitates designing biliary reconstructions that facilitate future therapeutic accessibility.

Several investigators have proposed modifying conventional Roux-en-Y reconstruction to improve endoscopic access [8,12,13]. This review summarizes current evidence on benign HJS, discusses existing treatment limitations, and introduces the concept of “future-proof” biliary reconstruction, emphasizing innovative surgical techniques like jejunoduodenal access reconstruction.

2. Epidemiology and Clinical Impact of Benign Hepaticojejunostomy Stricture

Benign hepaticojejunostomy stricture (HJS) is a well-recognized long-term complication and a major source of morbidity after hepatobiliary surgery. Despite technical advances,

the incidence of late biliary complications remains at 5% to 30%, reflecting variations in patient populations, surgical indications, and follow-up durations [3–5].

The risk of HJS is particularly high after complex reconstructions for perihilar, intrahepatic, or gallbladder carcinomas, and benign diseases requiring multiple anastomoses [1,2,14]. Contributing factors include bile duct ischemia, excessive anastomotic tension, small duct diameter, postoperative bile leakage, local infection, and recurrent cholangitis [3,15]. Extensive hilar dissection and major hepatectomy can further compromise peribiliary vascular supply, increasing susceptibility to ischemic fibrosis [16].

The timing of HJS development is highly variable; it can present within the first postoperative year or surface several years later. Large cohort studies indicate that the cumulative incidence of HJS increases over time, necessitating lifelong surveillance as oncologic advancements prolong patient survival [1,2,5,17].

Clinically, HJS manifests as cholestatic enzyme abnormalities, fever, abdominal pain, jaundice, or recurrent cholangitis [6,7]. Recurrent cholangitis is particularly critical, as repeated bacterial contamination and chronic inflammation accelerate anastomotic fibrosis. This creates a self-perpetuating cycle of obstruction and infection [18]. Left untreated, HJS can cause serious sequelae, including intrahepatic lithiasis, hepatic abscesses, segmental atrophy, secondary biliary cirrhosis, and hepatic failure [6,7,19]. These complications impair quality of life and may hinder systemic therapies for malignant diseases.

Crucially, the clinical burden of HJS depends heavily on anastomotic accessibility. Following major hepatectomy or bile duct resection with Roux-en-Y reconstruction, endoscopic access is often technically challenging or impossible [8,9]. Consequently, manageable strictures may ultimately require invasive percutaneous, EUS-guided, or surgical revisions [10,11].

The epidemiological characteristics, predisposing factors, and clinical consequences of benign HJS are summarized in Table 1. Ultimately, HJS should be viewed as a predictable long-term event. As long-term survival improves, these observations provide a strong clinical rationale for implementing future-proof, access-oriented biliary reconstruction strategies that preserve long-term therapeutic accessibility.

Table 1. Epidemiology, Risk Factors, and Clinical Consequences of Benign Hepaticojejunostomy Stricture.

Category	Findings	Representative References
Incidence	Reported incidence ranges from approximately 5–30% depending on surgical indication, reconstruction complexity, and follow-up duration	[3–5,14,17]
Time to Development	May occur within the first postoperative year but can develop many years after surgery; cumulative incidence increases over time	[5,17]
High-Risk Procedures	Extended hepatectomy with biliary reconstruction, perihilar cholangiocarcinoma resection, extrahepatic bile duct resection, multiple hepaticojejunostomies	[1,2,14,16]
Technical Risk Factors	Small bile duct diameter, anastomotic tension, ischemia, multiple anastomoses, bile leakage	[3,15,16]
Patient-Related Risk Factors	Postoperative infection, recurrent cholangitis, local inflammation, impaired healing	[15,18]
Initial Clinical Manifestations	Elevated liver enzymes, fever, abdominal pain, jaundice, recurrent cholangitis	[6,7]
Long-Term Complications	Recurrent pyogenic cholangitis, intrahepatic stones, hepatic abscess, liver atrophy, secondary biliary cirrhosis	[6,7,19]

Table 1. Cont.

Category	Findings	Representative References
Impact on Quality of Life	Repeated hospitalizations, recurrent interventions, prolonged antibiotic therapy	[6,19]
Impact on Healthcare Utilization	Increased need for endoscopic, radiologic, or surgical interventions	[10,11,19]
Clinical Significance	HJS should be regarded as a foreseeable long-term complication requiring lifelong surveillance and potential reintervention	[5,17]

3. Current Management of Hepaticojejunostomy Strictures

The management of benign HJS has evolved substantially over the past two decades. Advances in balloon enteroscopy-assisted endoscopic retrograde cholangiography (BE-ERCP), percutaneous transhepatic interventions, endoscopic ultrasound-guided biliary drainage (EUS-BD), and surgical revision have significantly expanded the therapeutic armamentarium [8,10,11]. The choice of treatment depends on anatomy, stricture severity, institutional expertise, and anastomotic feasibility. Currently available options are summarized in Table 2. Despite these technological developments, successful treatment remains critically dependent on anastomotic access. In patients undergoing major hepatobiliary surgery with complex Roux-en-Y reconstruction, anatomical limitations—rather than therapeutic capability—represent the principal obstacle, providing the rationale for reconstruction strategies designed to facilitate future endoscopic access.

Table 2. Current Treatment Modalities for Benign Hepaticojejunostomy Stricture.

Treatment Modality	Main Indications	Advantages	Limitations
Balloon Enteroscopy-Assisted ERCP (BE-ERCP)	First-line treatment when hepaticojejunostomy is endoscopically accessible	Minimally invasive; allows balloon dilation, stent placement, stone extraction, and cholangioscopy	Technical difficulty in long Roux-en-Y limbs; prolonged procedure time; limited availability of expertise
Double-Balloon Enteroscopy (DBE)-Assisted Intervention	Benign HJS in patients with surgically altered anatomy	High technical and clinical success rates; repeatable treatment	Failure to reach the anastomosis in complex anatomy; specialized equipment required
Single-Balloon Enteroscopy (SBE)-Assisted Intervention	Alternative to DBE in altered anatomy	Less complex equipment; effective in selected patients	Lower reachability in some cases; technically demanding
Percutaneous Transhepatic Biliary Drainage (PTBD)	Failed endoscopic access; acute cholangitis; urgent biliary decompression	High technical success; widely available; effective decompression	External drainage catheter; patient discomfort; risk of infection and catheter-related complications
Percutaneous Balloon Dilation	Refractory HJS or failed endoscopic therapy	Effective stricture dilation; repeatable	Requires transhepatic access; multiple sessions often necessary
EUS-Guided Biliary Drainage (EUS-BD)	Failed ERCP or inaccessible anastomosis	Internal drainage without external catheter; increasingly available	Technically complex; risk of bile leak, perforation, and stent-related adverse events
Temporary Plastic Stenting	Mild-to-moderate benign HJS	Simple; repeatable; removable	Multiple procedures required; stent occlusion
Fully Covered Self-Expandable Metal Stent (FCSEMS) Placement	Selected refractory strictures	Larger lumen; prolonged patency	Migration risk; limited evidence in HJS

Table 2. Cont.

Treatment Modality	Main Indications	Advantages	Limitations
Surgical Revision of Hepaticojejunostomy	Refractory or recurrent strictures not amenable to minimally invasive treatment	Definitive treatment in selected patients	High morbidity; technically demanding reoperation
Combined Multidisciplinary Approach	Complex recurrent HJS	Tailored treatment strategy	Requires coordination among surgeons, endoscopists, and interventional radiologists

3.1. Balloon Enteroscopy-Assisted Endoscopic Therapy

Endoscopic intervention is the preferred first-line treatment because it preserves physiological biliary drainage and avoids external catheters [7]. The introduction of device-assisted enteroscopy (double-balloon, single-balloon, and spiral) has significantly improved access to biliary-enteric anastomoses in altered anatomies [8,9]. Several studies have demonstrated favorable outcomes using BE-ERCP in Roux-en-Y hepaticojejunostomy, supporting its role as the current standard approach [8]. Interventions typically involve balloon dilation, temporary plastic stent placement, or fully covered self-expandable metal stents [20,21]. However, success depends heavily on anatomy; long Roux limbs, severe adhesions, sharp angulations, and multiple anastomoses can prevent successful intubation or anastomotic identification [8,9]. Furthermore, repeated sessions are frequently required for durable resolution in complex hilar reconstructions [22].

3.2. Percutaneous Transhepatic Interventions

Percutaneous transhepatic biliary drainage (PTBD) historically serves as the primary salvage treatment when endoscopic access fails [10]. PTBD offers high technical success rates by accessing the biliary tree directly through the liver, independent of gastrointestinal anatomy [23]. Following decompression, interventions include balloon dilation, internal-external catheter placement, and sequential upsizing protocols to remodel the stricture [24]. While long-term patency is favorable with prolonged catheter maintenance, PTBD severely impairs quality of life. External catheters require frequent exchanges and carry risks of dislodgement, bleeding, bile leakage, and recurrent infection [23,24]. Consequently, PTBD is increasingly reserved as a secondary option.

3.3. Endoscopic Ultrasound-Guided Biliary Drainage

EUS-BD has emerged as a crucial alternative when conventional ERCP is unfeasible [10]. Interventional EUS enables internal biliary drainage via EUS-guided hepaticogastrostomy (EUS-HGS), hepaticojejunostomy, or rendezvous techniques [25]. Recent comparative studies suggest EUS-BD achieves clinical outcomes comparable to PTBD while avoiding external catheters and improving patient comfort [10,26]. Nevertheless, EUS-BD remains technically demanding and limited to specialized centers. Potential adverse events include bile peritonitis, bleeding, stent migration, and perforation [25,26]. Additionally, altered post-hepatectomy anatomy can complicate sonographic visualization and procedural planning.

3.4. Surgical Revision

Surgical revision remains the definitive treatment for refractory HJS when less invasive modalities fail or when recurrent strictures cause repeated cholangitis and progressive liver dysfunction [11,19]. Surgery involves resecting the fibrotic anastomosis and constructing a new hepaticojejunostomy. Although providing durable long-term results, it carries significant technical complexity. Dense adhesions, altered vascular anatomy, previous hilar

dissection, and limited bile duct length increase operative difficulty and perioperative morbidity [11,27].

Despite remarkable progress, no single intervention is universally applicable. Endoscopic therapy is preferred but limited by anatomical accessibility. PTBD provides reliable drainage but compromises quality of life. EUS-guided approaches are promising but technically demanding, while surgical revision is invasive and high-risk [8,10,11]. Ultimately, the success of all modalities depends on the ability to reach the anastomosis. Therefore, HJS management must shift from selecting interventions post-facto to anticipating future access requirements during the initial reconstruction, forming the basis for future-proof biliary reconstruction.

4. Why Endoscopic Access Remains Challenging After Major Hepatobiliary Surgery

The development of balloon-assisted enteroscopy, advanced accessories, and EUS-guided interventions has expanded the therapeutic options for benign HJS [8–10,25,26]. Nevertheless, success remains fundamentally dependent on accessing the biliary-enteric anastomosis. In patients undergoing major hepatobiliary surgery—particularly extended hepatectomy or extrahepatic bile duct resection with Roux-en-Y reconstruction—endoscopic access frequently remains the principal obstacle [8,9]. Unlike pancreaticoduodenectomy, where the anastomosis is relatively close to the stomach and accessible via conventional or short enteroscopy, post-hepatectomy reconstruction typically involves a long Roux limb and complex anatomy, creating substantial technical difficulties even for experts [28].

4.1. Long Roux Limb and Excessive Enteroscopic Distance

A major anatomical barrier is Roux limb length, where the distance between the upper gastrointestinal tract and the anastomosis often exceeds 50–70 cm [29]. This deep insertion prolongs procedure time, reduces endoscope maneuverability, and increases failure rates. Although device-assisted enteroscopy has improved access, success remains variable, particularly after extensive surgery, increasing patient discomfort and sedation requirements [8,22].

4.2. Postoperative Adhesions and Intestinal Fixation

Extensive hilar dissection, lymphadenectomy, vascular reconstruction, and major hepatectomy frequently induce dense intra-abdominal adhesions [16,30]. These adhesions alter bowel orientation, restrict advancement, and create fixed angulations within the afferent limb. Recurrent postoperative cholangitis or prior interventions further exacerbate adhesion formation, making endoscopic access progressively difficult over time.

4.3. Sharp Angulation and Altered Intestinal Geometry

Roux-en-Y reconstruction frequently creates sharp intestinal bends and complex loops that compromise endoscope stability and device manipulation [9,31]. Maintaining a stable position during guidewire insertion, balloon dilation, or stenting is technically challenging. Furthermore, forward-viewing enteroscopes offer a different perspective than side-viewing duodenoscopes, making selective biliary cannulation highly demanding [9].

4.4. Multiple Hepaticojejunostomies and Complex Hilar Anatomy

Surgery for perihilar cholangiocarcinoma often requires reconstructing multiple segmental bile ducts, resulting in several small, complex anastomoses [1,2,32]. When strictures form, identifying the culprit lumen is difficult. Because draining one segment does not en-

sure global decompression, multiple cannulations, selective cholangiography, and repeated interventions are required, increasing failure and recurrence rates [32].

4.5. *Progressive Fibrosis Associated with Recurrent Cholangitis*

Chronic inflammation drives progressive fibrosis at the anastomosis and surrounding tissues [18]. Repeated bouts distort the biliary-enteric junction, obscuring the anatomy and reducing therapeutic efficacy [33]. Moreover, in emergency settings where prolonged enteroscopy is impractical, alternative drainage like PTBD is frequently necessitated [10,23].

4.6. *Limitations of Current Technological Solutions*

While advanced modalities like motorized spiral enteroscopy and EUS-BD have expanded therapeutic possibilities, they require specialized equipment, high operator expertise, and substantial time [8,25,34]. Crucially, their success remains bound by the anatomy established during the initial surgery. Current strategies largely manage the consequences of difficult access rather than preventing it, a reactive approach that is increasingly inadequate as patient survival prolongs.

These persistent challenges indicate that postoperative biliary intervention is a multidisciplinary issue originating at the initial operation. Biliary reconstruction geometry directly dictates future endoscopic accessibility. Therefore, the emerging paradigm of access-oriented reconstruction integrates long-term accessibility into operative planning. Anticipating late strictures allows surgeons to design future-proof reconstructions, simplifying subsequent interventions and reducing reliance on invasive revisions.

5. Evolution of Access-Oriented Reconstruction

Historically, the primary objective of biliary reconstruction has been restoring biliary continuity while minimizing bile leakage, cholangitis, and anastomotic failure. Consequently, conventional Roux-en-Y hepaticojejunostomy became the standard technique following major hepatobiliary procedures due to its short-term reliability [1,2,30]. For decades, postoperative biliary intervention remained a secondary issue, with little attention paid to anastomotic accessibility.

However, the clinical landscape has changed. Advances in surgical techniques, perioperative care, and oncologic therapies have prolonged long-term survival after extended hepatectomy, bile duct resection, and surgery for perihilar cholangiocarcinoma [1,2]. Consequently, late complications, particularly benign hepaticojejunostomy strictures (HJSs), are encountered with increasing frequency [3–5,17]. The rising need for repeated interventions has exposed a fundamental limitation of conventional reconstruction: successful treatment often depends not on therapeutic modality but on the ability to reach the anastomosis [8,9,28,29].

This realization has fostered a new reconstructive philosophy that integrates long-term accessibility into initial surgical planning. Anticipating postoperative strictures and recurrent cholangitis, access-oriented reconstruction aims to establish both effective drainage and future therapeutic access. As summarized in Table 3, strategies have progressed from conventional Roux-en-Y to intervention-oriented approaches, including access loops and modified reconstructions. This evolution has led to the proposal of Future Access Biliary Reconstruction (FABR), a conceptual reconstruction strategy that incorporates lifelong endoscopic accessibility into the initial operative design.

Table 3. Evolution of Access-Oriented Biliary Reconstruction.

Era/Concept	Reconstruction Strategy	Primary Objective	Advantages	Limitations
Conventional Reconstruction	Standard Roux-en-Y hepaticojejunostomy	Restoration of biliary continuity and prevention of bile leakage	Well established; durable long-term biliary drainage	Difficult endoscopic access in the event of late biliary complications
Intervention-Oriented Reconstruction	Modified Roux-en-Y configurations with shortened or marked access limbs	Facilitation of future biliary intervention	Improved identification of the biliary limb	Limited adoption; accessibility remains variable
Access Loop Reconstruction	Permanent jejunal access loop	Preservation of future radiologic or endoscopic access	Enables repeated postoperative intervention	Additional reconstruction complexity; limited contemporary use
Gastric Access Loop Reconstruction	Hepaticojejunostomy combined with a gastric access loop	Simplification of postoperative endoscopic access	High endoscopic accessibility; reduced need for percutaneous intervention	Additional anastomosis; concerns regarding reflux and long-term durability
Duodenal Access Reconstruction	Jejunoduodenal access route to the biliary limb	Direct endoscopic access through the duodenum	Shorter and more physiological access route	Limited clinical experience; need for long-term validation
Future Access Biliary Reconstruction (FABR)	Side-to-side jejunoduodenostomy between the elevated jejunal limb and second portion of the duodenum	Preservation of lifelong therapeutic accessibility	Facilitates standard endoscopic access, potentially reducing PTBD and revisional surgery	Requires prospective evaluation and long-term outcome data

5.1. From Functional Reconstruction to Intervention-Oriented Reconstruction

Intervention-oriented reconstruction emerged alongside therapeutic endoscopy advances. As balloon-assisted enteroscopy expanded altered-anatomy interventions, surgeons recognized that initial reconstructive geometry strongly dictated subsequent therapeutic success [8,22,31]. Roux limb length, hepaticojejunostomy location, and bowel configuration significantly affect future endoscopic feasibility [29,34,35]. Crucially, this paradigm mirrors vascular access planning in dialysis surgery or endoscopic surveillance design after esophagectomy and gastrectomy, suggesting biliary reconstruction should similarly anticipate future requirements.

5.2. Development of Access Loop Techniques

Early efforts to improve accessibility involved creating access loops to provide a recognizable, shorter route to the biliary limb for future endoscopic or radiologic interventions [35,36]. Access loops ease afferent limb identification and reduce procedural complexity during repeated interventions. Recently, Tokumitsu et al. reported a novel reconstruction approach facilitating postoperative endoscopy, reinforcing that benign HJS management begins at the index operation [12].

5.3. Integration of Endoscopic and Surgical Perspectives

Traditionally, surgeons focused on creating durable anastomoses, while endoscopists addressed complications post-facto. The complexity of long-term care now demands closer interdisciplinary integration. Balloon enteroscopy-assisted ERCP achieves excellent outcomes when the hepaticojejunostomy is accessible [8]; conversely, technical failures are frequently driven by anatomical constraints rather than endoscopic limitations [9,22,31]. Thus, surgical

design and endoscopic intervention are complementary components of a continuum of care that reduces reliance on invasive percutaneous or surgical revisions [10,11,23].

5.4. Emerging Reconstruction Strategies for Future Biliary Access

Contemporary techniques facilitating future endoscopic access include shortened Roux limbs, marked access loops, modified jejunal configurations, and direct access routes [12,13,35–37]. Modifications incorporating duodenal or gastric access routes have gained attention. By creating a direct pathway to the biliary limb, these techniques overcome conventional Roux-en-Y limitations, such as excessive insertion distance, sharp angulations, and poor maneuverability [13]. Early reports suggest they simplify interventions and reduce percutaneous drainage needs without replacing established biliary reconstruction methods [12,13].

5.5. The Emergence of the Future-Proof Reconstruction Concept

The concept of future-proof reconstruction has recently emerged as a conceptual extension of access-oriented reconstruction. FABR represents one proposed strategy within this emerging framework [3–6,17]. Future-proof reconstruction incorporates long-term therapeutic needs into operative decision-making to preserve lifelong minimally invasive options, providing a logical foundation for the jejunoduodenal access reconstruction techniques discussed in the following section.

6. Future Access Biliary Reconstruction (FABR): Jejunoduodenal Bypass for Future Endoscopic Access

6.1. Rationale

Despite substantial advances in balloon-assisted enteroscopy, endoscopic ultrasound-guided biliary drainage (EUS-BD), and percutaneous interventions, the long-term management of benign hepaticojejunostomy stricture (HJS) continues to be limited by anastomotic accessibility rather than the availability of therapeutic modalities [8–10,23,25,26]. In patients undergoing major hepatobiliary surgery—particularly extended hepatectomy or extrahepatic bile duct resection—the combination of long Roux limbs and surgically altered anatomy frequently impedes timely endoscopic intervention [8,9,28,29].

Previous investigators have explored various access-oriented reconstruction strategies, including access loops, gastric access routes, and jejunoduodenal bypasses, to facilitate future endoscopic intervention [35–37]. These studies collectively suggest that reconstructive design may influence the feasibility of subsequent biliary intervention. Building upon these concepts, we propose Future Access Biliary Reconstruction (FABR) as a conceptual reconstruction strategy that incorporates a dedicated access route during the index operation with the goal of preserving lifelong endoscopic accessibility. Rather than replacing conventional hepaticojejunostomy, FABR is intended as a hypothesis-generating approach that warrants future clinical evaluation.

6.2. Surgical Concept

The proposed FABR technique consists of a conventional Roux-en-Y hepaticojejunostomy followed by the creation of a side-to-side jejunoduodenostomy between the elevated jejunal limb and the second portion of the duodenum. Conceptually, this additional anastomosis establishes communication between the duodenal lumen and the biliary limb while preserving the original hepaticojejunostomy.

The anticipated advantage of this configuration is that it may provide a shorter and more direct endoscopic route than conventional Roux-en-Y reconstruction, potentially allowing the hepaticojejunostomy to be reached using standard upper gastrointestinal

endoscopy rather than prolonged balloon-assisted enteroscopy. Historical reports have described similar jejunoduodenal access procedures for hepatolithiasis and benign biliary disease [38–40]; however, comparable approaches have not been systematically evaluated in contemporary oncologic hepatobiliary surgery. Accordingly, FABR should currently be regarded as a conceptual extension of these previously described access-oriented techniques rather than as an established reconstructive standard. The conceptual configuration of conventional Roux-en-Y hepaticojejunostomy and the proposed Future Access Biliary Reconstruction (FABR) are illustrated in Figure 1. Compared with conventional reconstruction, the proposed jejunoduodenostomy creates a shorter and more direct endoscopic route to the hepaticojejunostomy while preserving the original biliary-enteric anastomosis. This illustration is intended to demonstrate the anatomical concept of FABR and should not be interpreted as evidence of established clinical superiority (Figure 1).

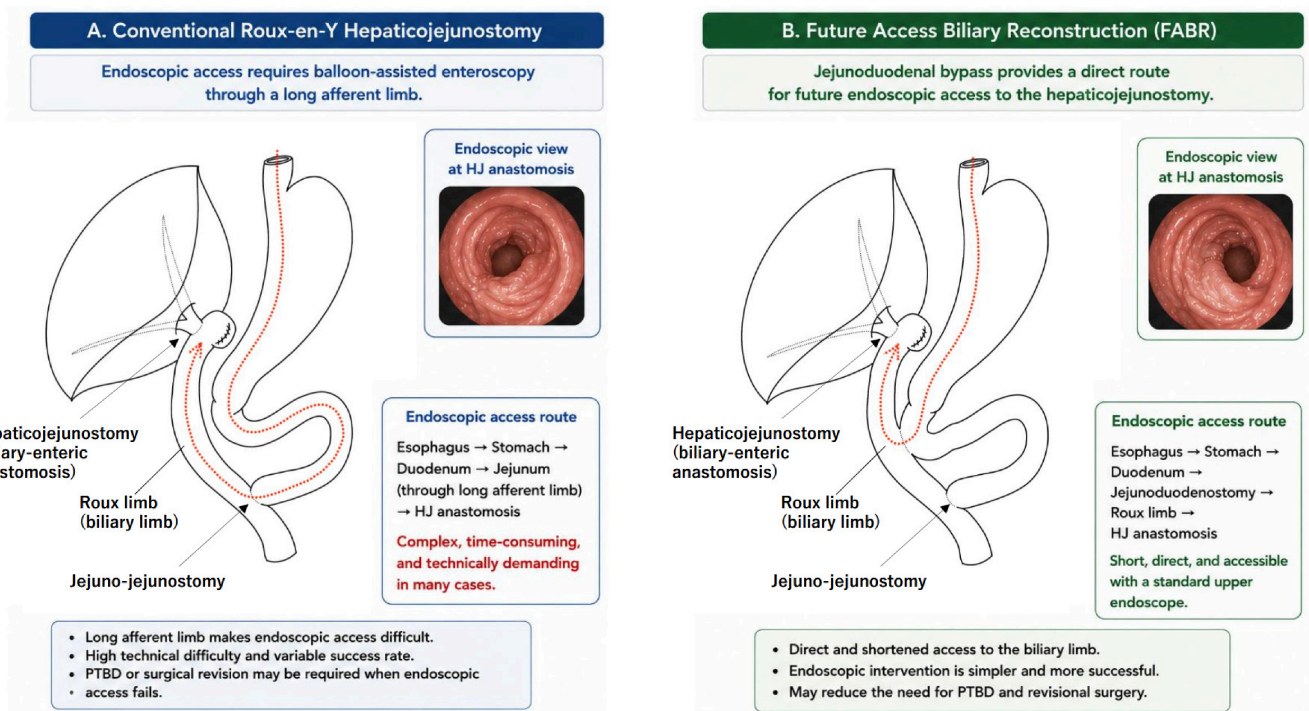


Figure 1. Future Access Biliary Reconstruction (FABR): Concept and Surgical Configuration. **(A) Conventional Roux-en-Y hepaticojejunostomy after major hepatobiliary surgery.** In this configuration, endoscopic access to the hepaticojejunostomy often requires balloon-assisted enteroscopy through a long and anatomically complex Roux limb. As a result, management of benign hepaticojejunostomy stricture (HJS) may be technically challenging and may require percutaneous transhepatic biliary drainage (PTBD) or surgical revision when endoscopic access fails. **(B) Future Access Biliary Reconstruction (FABR).** Following construction of a standard Roux-en-Y hepaticojejunostomy, a side-to-side jejunoduodenostomy is created between the elevated jejunal limb and the second portion of the duodenum. This additional anastomosis establishes a direct and shortened route from the stomach and duodenum to the biliary limb, facilitating future endoscopic access to the hepaticojejunostomy. The technique is intended to simplify endoscopic management of postoperative biliary complications, including benign HJS, recurrent cholangitis, intrahepatic stones, and biliary obstruction. Abbreviations: HJ, hepaticojejunostomy; HJS, hepaticojejunostomy stricture; PTBD, percutaneous transhepatic biliary drainage; FABR, Future Access Biliary Reconstruction.

6.3. Potential Clinical Advantages

The principal rationale underlying FABR is the preservation of future therapeutic accessibility throughout long-term follow-up. Because benign HJS may develop many

years after surgery [3–6,17], maintaining reliable endoscopic access could facilitate less invasive management when delayed biliary complications occur.

Our institution has previously reported successful endoscopic management using jejunoduodenostomy access after hepaticojejunostomy, demonstrating technical feasibility in selected patients, although larger prospective studies are required to establish long-term efficacy [12,13]. Based on our institutional experience with access-oriented reconstruction in selected patients, endoscopic access through a jejunoduodenal bypass appears technically feasible and may simplify identification of the hepaticojejunostomy during subsequent interventions. This approach may facilitate balloon dilation, cholangioscopy, stone extraction, and stent placement while potentially reducing dependence on more invasive procedures. However, these observations are based on limited clinical experience and should not be interpreted as definitive evidence of superiority.

Similarly, previous reports evaluating gastric access loops and modified access-oriented reconstructions have demonstrated encouraging endoscopic accessibility and reduced reliance on percutaneous approaches in selected settings [41–43]. Nevertheless, the available evidence remains limited, and whether these potential technical advantages translate into improved long-term clinical outcomes, lower reintervention rates, enhanced quality of life, or reduced healthcare utilization has yet to be established through prospective comparative studies.

6.4. Patient Selection

Although Future Access Biliary Reconstruction (FABR) could theoretically be incorporated into any hepaticojejunostomy, its routine use cannot currently be recommended because clinical evidence supporting its safety and long-term efficacy remains limited. At present, FABR should be regarded as a selective reconstructive option that may be considered in carefully chosen patients in whom future biliary intervention is anticipated to be technically challenging.

Patients who may derive the greatest benefit include those undergoing surgery for perihilar cholangiocarcinoma, gallbladder carcinoma requiring bile duct resection, extended hepatectomy, multiple hepaticojejunostomies, reoperative biliary reconstruction, or other complex hilar procedures [1–6,17]. These operations are frequently associated with altered biliary anatomy, multiple biliary-enteric anastomoses, and a relatively high incidence of late benign biliary complications requiring repeated intervention. In such circumstances, preserving a shorter and more accessible endoscopic route may facilitate future management should biliary strictures, intrahepatic stones, or recurrent cholangitis develop.

Conversely, the potential advantages of FABR may be less apparent in patients undergoing straightforward biliary reconstruction with a low anticipated risk of future biliary intervention. Therefore, decisions regarding the incorporation of access-oriented reconstruction should be individualized after consideration of disease characteristics, anatomical complexity, expected long-term survival, and the likelihood of requiring future biliary access.

Further prospective multicenter studies are needed to establish evidence-based patient-selection criteria, identify the clinical scenarios in which FABR offers the greatest benefit, and determine whether selective application of this concept improves long-term clinical outcomes compared with conventional Roux-en-Y hepaticojejunostomy.

To facilitate comparison between the proposed FABR concept and previously described reconstructive strategies, Table 4 summarizes the principal characteristics, anticipated advantages, potential limitations, and current level of clinical evidence for representative access-oriented biliary reconstruction techniques. This comparison highlights that FABR should currently be regarded as a conceptual extension of earlier access-preserving approaches rather than an established reconstructive standard.

Table 4. Comparison of Conventional Roux-en-Y Hepaticojejunostomy, Access-Oriented Reconstruction Techniques, and Future Access Biliary Reconstruction (FABR).

Reconstruction Technique	Principle of Biliary Access	Potential Advantages	Potential Disadvantages	Current Clinical Evidence
Conventional Roux-en-Y hepaticojejunostomy	No dedicated access route; biliary intervention usually requires balloon-assisted enteroscopy or percutaneous drainage	Well-established standard technique; excellent long-term durability; widely applicable	Difficult endoscopic access after benign stricture; prolonged procedures; PTBD or reoperation may be required	Extensive long-term evidence; current standard of care
Access loop reconstruction	Externalized or marked jejunal limb facilitates future endoscopic localization	Improved identification of the biliary limb; facilitates repeat intervention	Cosmetic concerns; additional bowel manipulation; variable long-term use	Small retrospective series; limited evidence
Transgastric access reconstruction	Gastric route provides access to the biliary limb	Relatively straightforward endoscopic approach; shorter access route	Risk of reflux, ulceration, altered gastric anatomy	Limited institutional reports
Jejunoduodenal access reconstruction	Side-to-side jejunoduodenostomy allows direct access from the duodenum	Potentially easier conventional endoscopic access; avoids prolonged enteroscopy	Possible enterobiliary reflux, bacterial colonization, bile stasis, marginal ulcer, increased operative complexity	Small case series; limited long-term validation
Future Access Biliary Reconstruction (FABR)	Planned jejunoduodenal bypass incorporated during the initial operation to preserve lifelong endoscopic access	Conceptually facilitates future ERCP-like access; may reduce dependence on PTBD or revisional surgery; designed for long-term management	Long-term efficacy unproven; theoretical risks of reflux cholangitis, bacterial colonization, altered intestinal physiology, additional operative complexity; requires prospective validation	Conceptual strategy supported by anatomical rationale and limited institutional experience; prospective studies required

6.5. Potential Disadvantages

Although Future Access Biliary Reconstruction (FABR) is intended to improve long-term endoscopic accessibility, the addition of a jejunoduodenostomy may introduce several theoretical disadvantages that should be carefully considered before broader clinical application.

First, the creation of a direct communication between the duodenum and the biliary limb may increase exposure of the biliary tract to enteric contents. Duodenobiliary reflux has been recognized as one of the principal concerns following hepaticoduodenostomy and other biliary-enteric reconstructions, with reports describing bile reflux gastritis, duodenogastric reflux, and chronic exposure of the biliary epithelium to intestinal contents [44,45]. Although current evidence suggests that the incidence of postoperative cholangitis is not consistently higher than that observed after Roux-en-Y hepaticojejunostomy, persistent enterobiliary reflux remains a theoretical mechanism that could contribute to recurrent biliary inflammation in selected patients [44,46,47].

Second, bacterial colonization of the biliary tree may represent another potential concern. Experimental studies have demonstrated rapid bacterial colonization of hepaticojejunostomy limbs and translocation of enteric bacteria into the intrahepatic biliary system after biliary reconstruction, suggesting that chronic bacterial contamination may contribute to recurrent cholangitis and long-term biliary injury [48]. Whether the additional jejunoduodenal communication proposed in FABR alters this process remains unknown and warrants careful investigation.

Third, altered intestinal flow through the access limb could theoretically promote bile stasis, food residue retention, or impaired drainage. Similar mechanisms have been implicated in non-stenotic recurrent cholangitis following hepaticojejunostomy, where intestinal reflux rather than anastomotic narrowing appears to play a major pathogenic role [43]. Although such complications have not been systematically evaluated in access-oriented reconstruction, they should be considered during future clinical assessment.

Additional concerns include the possibility of marginal ulceration at the jejunoduodenostomy, particularly in the presence of prolonged exposure to gastric acid or bile reflux. Although the incidence of this complication has not been established for FABR, ulcer formation represents a recognized complication after several gastrointestinal bypass procedures and may require long-term endoscopic surveillance [44,49].

From a surgical perspective, construction of an additional anastomosis inevitably increases operative complexity and may modestly prolong operative time. While these increases are unlikely to be substantial in experienced hepatobiliary centers, they may influence operative risk in elderly or medically frail patients. Furthermore, the additional intestinal anastomosis could increase the complexity of future reoperative abdominal surgery because of postoperative adhesions and altered anatomy.

The long-term physiological consequences of creating a permanent jejunoduodenal bypass remain uncertain. Although clinically significant nutritional disturbances have not been reported in previous access-oriented reconstructions, long-term effects on intestinal transit, bile circulation, and digestive physiology have not been systematically evaluated. Consequently, routine implementation of FABR cannot currently be recommended outside carefully selected patients until prospective studies establish its safety and long-term clinical benefit.

6.6. Potential Concerns

The creation of an additional jejunoduodenostomy inevitably introduces several theoretical concerns that should be carefully considered before wider clinical adoption. Potential disadvantages include enterobiliary reflux, bacterial colonization of the biliary tree, bile stasis, reflux cholangitis, and the possible development of marginal ulceration, all of which have been discussed previously in relation to hepaticoduodenostomy and other access-oriented biliary reconstructions [50,51]. Additional considerations include increased operative complexity, modest prolongation of operative time, possible nutritional consequences, and technical challenges should subsequent abdominal surgery become necessary.

Published experiences with gastric and duodenal access procedures have generally reported acceptable morbidity and favorable long-term outcomes [40–43]. However, these studies involved relatively small patient populations and heterogeneous indications. Consequently, the long-term safety profile of FABR cannot currently be assumed and requires prospective validation with careful assessment of postoperative complications, biliary function, quality of life, and long-term durability.

6.7. Future Perspectives

Most contemporary advances in biliary intervention have focused on overcoming anatomical barriers after postoperative complications have already developed. FABR represents a different conceptual strategy by proposing that future therapeutic accessibility should be considered during the initial reconstructive procedure.

At present, FABR should be viewed as a hypothesis-generating surgical concept rather than an established standard of care. Future prospective multicenter studies comparing conventional Roux-en-Y reconstruction with access-oriented reconstruction will be necessary to determine whether preservation of endoscopic access results in clinically meaningful

improvements in long-term outcomes. Such investigations should evaluate technical feasibility, postoperative morbidity, biliary complications, reintervention rates, quality of life, healthcare utilization, and cost-effectiveness.

If validated, FABR could represent one potential approach within the broader concept of future-proof hepatobiliary reconstruction, in which surgical planning extends beyond immediate anatomical reconstruction to include anticipated long-term therapeutic needs.

To illustrate the potential clinical application of this concept, Figure 2 presents a proposed clinical algorithm for the management of benign hepaticojejunostomy stricture and the possible role of Future Access Biliary Reconstruction (FABR). Rather than recommending routine implementation, the algorithm highlights clinical scenarios in which access-oriented reconstruction may be considered during the initial operation, particularly for patients anticipated to require complex long-term biliary surveillance or repeated therapeutic intervention. Because FABR remains a conceptual strategy, the proposed algorithm should be regarded as a hypothesis-generating framework requiring prospective clinical validation.

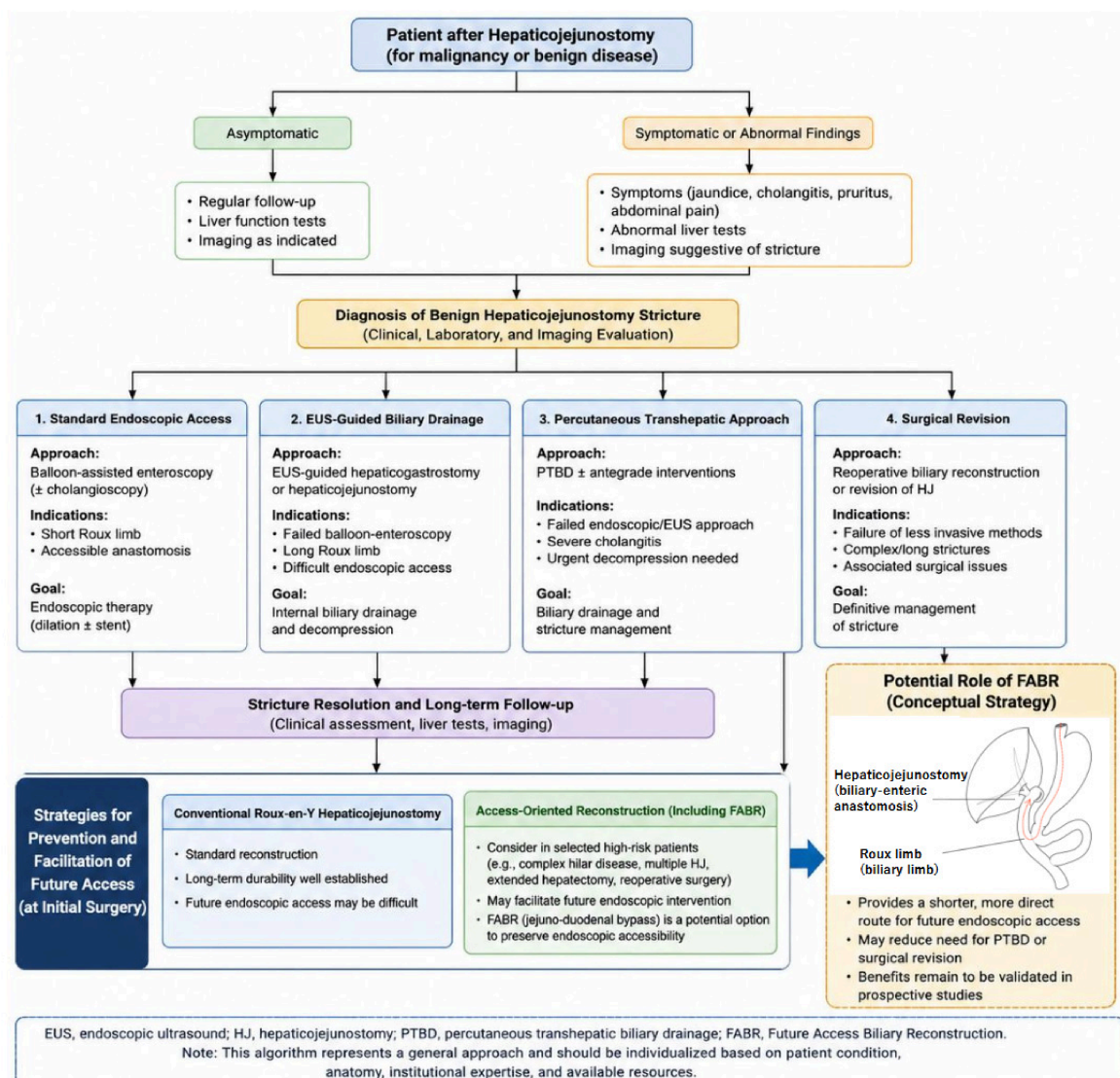


Figure 2. Proposed Clinical Algorithm for the Management of Benign Hepaticojejunostomy Stricture and the Potential Role of Future Access Biliary Reconstruction (FABR).

This conceptual algorithm summarizes the current management pathway for patients following hepaticojejunostomy and illustrates the potential role of Future Access Biliary Reconstruction (FABR) in preserving long-term endoscopic accessibility. Following postoperative surveillance, patients with suspected benign hepaticojejunostomy stricture undergo clinical, laboratory, and imaging evaluation before treatment is selected according to anatomical accessibility and disease severity. Standard endoscopic therapy, endoscopic ultrasound-guided biliary drainage (EUS-BD), percutaneous transhepatic biliary drainage (PTBD), and surgical revision remain established therapeutic options. FABR is presented as a proposed access-oriented reconstructive strategy that may be considered during the initial operation in carefully selected high-risk patients to facilitate future endoscopic intervention. The algorithm is conceptual and does not represent a validated clinical guideline. Further investigations should include prospective multicenter comparative trials evaluating long-term endoscopic accessibility, postoperative complications, quality of life, healthcare utilization, cost-effectiveness, and patient-reported outcomes.

7. Future Directions: Toward Future-Proof Hepatobiliary Reconstruction

The management of benign hepaticojejunostomy stricture (HJS) has evolved considerably. Advances in balloon-assisted enteroscopy, interventional radiology, and endoscopic ultrasound-guided biliary drainage (EUS-BD) have substantially expanded the available therapeutic options. Nevertheless, successful treatment continues to depend largely on anastomotic accessibility, particularly in patients with complex postoperative anatomy [8–10,23,25,26]. Historically, most technical innovations have focused on overcoming anatomical barriers after postoperative complications have already developed [8,9,23,25,34]. Although these approaches have improved the management of HJS, they remain reactive solutions to challenges that originate during the initial reconstructive procedure.

As long-term survival continues to improve following major hepatobiliary surgery, increasing attention is being directed toward reconstructive strategies that consider not only immediate biliary continuity but also the feasibility of future therapeutic interventions [1,2,17]. In this context, the concept of future-proof hepatobiliary reconstruction has emerged as a potential framework for integrating anticipated long-term management into operative planning. Rather than representing a replacement for conventional reconstruction, this concept encourages surgeons to consider future accessibility alongside established surgical principles when appropriate.

Access-oriented reconstruction techniques represent one possible application of this evolving philosophy [12,13,35,50,51]. By preserving a more favorable route to the biliary limb, these approaches may facilitate future endoscopic intervention in selected patients. Consequently, they have the potential to reduce reliance on percutaneous drainage or revisional surgery, although these potential clinical benefits remain to be confirmed in appropriately designed prospective studies. Within this conceptual framework, Future Access Biliary Reconstruction (FABR) represents one proposed reconstructive strategy intended to preserve long-term endoscopic accessibility rather than an established standard of care.

Several important questions remain unanswered. Future multicenter prospective studies should evaluate whether access-oriented reconstruction improves long-term biliary patency, reduces recurrent cholangitis, decreases the need for PTBD or surgical revision, lowers reintervention rates, enhances quality of life, and reduces healthcare utilization. Comparative studies between conventional Roux-en-Y reconstruction and FABR will also be necessary to clarify patient-selection criteria and identify those most likely to benefit from access-oriented reconstruction.

In parallel, continuing advances in direct cholangioscopy, robotic endoscopy, artificial intelligence-assisted navigation, and next-generation therapeutic platforms may further expand the potential value of preserving endoscopic accessibility. Whether reconstruction strategies designed with future intervention in mind will improve long-term clinical outcomes remains to be determined through clinical investigation.

Ultimately, future-proof hepatobiliary reconstruction should be regarded as an evolving conceptual framework that seeks to integrate surgical durability with long-term therapeutic accessibility. The optimal management of future biliary complications may begin not only when strictures develop but also during the planning of the initial reconstruction. Further clinical validation will determine the role of this concept in routine hepatobiliary surgical practice.

Importantly, the currently available evidence primarily supports the feasibility of access-oriented biliary reconstruction techniques rather than the routine clinical implementation of FABR itself. FABR should therefore be regarded as a conceptual extension of previously reported reconstructive strategies based on anatomical rationale and limited institutional experience, rather than an evidence-established surgical standard. Its potential clinical value requires confirmation through prospective comparative studies before widespread adoption can be recommended.

8. Conclusions

Benign hepaticojejunostomy stricture remains one of the most important long-term complications following biliary reconstruction, and successful management continues to depend largely on the feasibility of biliary access. Although substantial advances in balloon-assisted enteroscopy, endoscopic ultrasound-guided biliary drainage, and interventional radiology have expanded the available therapeutic options, altered postoperative anatomy continues to present a major challenge in many patients [8–10,23,25,26].

The concept of future-proof hepatobiliary reconstruction proposes that consideration of future therapeutic accessibility may be incorporated into reconstructive planning at the time of the initial operation. Within this conceptual framework, Future Access Biliary Reconstruction (FABR) represents one proposed access-oriented reconstructive strategy intended to facilitate subsequent endoscopic intervention in selected patients. Although this approach has a sound anatomical rationale and builds upon previously described access-oriented techniques [35–45], its long-term clinical value has not yet been established.

At present, FABR should therefore be regarded as a hypothesis-generating concept rather than an established standard of care. Future prospective multicenter studies comparing conventional Roux-en-Y hepaticojejunostomy with access-oriented reconstruction will be required to determine whether preservation of endoscopic accessibility translates into meaningful improvements in long-term biliary outcomes, quality of life, healthcare utilization, and overall patient care.

As survival after major hepatobiliary surgery continues to improve, reconstructive strategies that consider both immediate surgical success and future therapeutic accessibility may become increasingly relevant. Whether future-proof hepatobiliary reconstruction will ultimately influence routine surgical practice remains to be determined through rigorous clinical investigation.

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References

1. Tsao, J.I.; Nimura, Y.; Kamiya, J.; Hayakawa, N.; Kondo, S.; Nagino, M.; Miyachi, M.; Kanai, M.; Uesaka, K.; Oda, K.; et al. Management of hilar cholangiocarcinoma: Comparison of an American and a Japanese experience. *Ann. Surg.* **2000**, *232*, 166–174. [[CrossRef](#)] [[PubMed](#)]
2. Nagino, M.; Ebata, T.; Yokoyama, Y.; Igami, T.; Sugawara, G.; Takahashi, Y.; Nimura, Y. Evolution of surgical treatment for perihilar cholangiocarcinoma: A single-center 34-year review of 574 consecutive resections. *Ann. Surg.* **2013**, *258*, 129–140. [[CrossRef](#)] [[PubMed](#)]
3. Halle-Smith, J.M.; Hall, L.A.; Mirza, D.F.; Roberts, K.J. Risk factors for anastomotic stricture after hepaticojejunostomy for bile duct injury—A systematic review and meta-analysis. *Surgery* **2021**, *170*, 1310–1316. [[CrossRef](#)] [[PubMed](#)]
4. House, M.G.; Cameron, J.L.; Schulick, R.D.; Campbell, K.A.; Sauter, P.K.; Coleman, J.; Lillemoe, K.D.; Yeo, C.J. Incidence and outcome of biliary strictures after pancreaticoduodenectomy. *Ann. Surg.* **2006**, *243*, 571–576; discussion 576–578. [[CrossRef](#)] [[PubMed](#)]
5. Dimou, F.M.; Adhikari, D.; Mehta, H.B.; Olino, K.; Riall, T.S.; Brown, K.M. Incidence of hepaticojejunostomy stricture after hepaticojejunostomy. *Surgery* **2016**, *160*, 691–698. [[CrossRef](#)] [[PubMed](#)]
6. de’Angelis, N.; Catena, F.; Memeo, R.; Coccolini, F.; Martínez-Pérez, A.; Romeo, O.M.; De Simone, B.; Di Saverio, S.; Brustia, R.; Rhaïem, R.; et al. 2020 WSES guidelines for the detection and management of bile duct injury during cholecystectomy. *World J. Emerg. Surg.* **2021**, *16*, 30. [[CrossRef](#)] [[PubMed](#)]
7. Costamagna, G.; Pandolfi, M.; Mutignani, M.; Spada, C.; Perri, V. Long-term results of endoscopic management of postoperative bile duct strictures with increasing numbers of stents. *Gastrointest. Endosc.* **2001**, *54*, 162–168. [[CrossRef](#)] [[PubMed](#)]
8. Okabayashi, T.; Shima, Y.; Sumiyoshi, T.; Sui, K.; Iwata, J.; Morita, S.; Iiyama, T.; Shimada, Y. Incidence and Risk Factors of Cholangitis after Hepaticojejunostomy. *J. Gastrointest. Surg.* **2018**, *22*, 676–683. [[CrossRef](#)] [[PubMed](#)]
9. Inamdar, S.; Slattery, E.; Sejal, D.V.; Miller, L.S.; Pleskow, D.K.; Berzin, T.M.; Trindade, A.J. Systematic review and meta-analysis of single-balloon enteroscopy-assisted ERCP in patients with surgically altered GI anatomy. *Gastrointest. Endosc.* **2015**, *82*, 9–19. [[CrossRef](#)] [[PubMed](#)]
10. van der Merwe, S.W.; van Wanrooij, R.L.J.; Bronswijk, M.; Everett, S.; Lakhtakia, S.; Rimbaz, M.; Hucl, T.; Kunda, R.; Badaoui, A.; Law, R.; et al. Therapeutic endoscopic ultrasound: European Society of Gastrointestinal Endoscopy (ESGE) Guideline. *Endoscopy* **2022**, *54*, 185–205. [[CrossRef](#)] [[PubMed](#)]
11. Booi, K.A.C.; Coelen, R.J.; de Reuver, P.R.; Besselink, M.G.; van Delden, O.M.; Rauws, E.A.; Busch, O.R.; van Gulik, T.M.; Gouma, D.J. 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. [[CrossRef](#)] [[PubMed](#)]
12. Sakamoto, S.; Sui, K.; Tabuchi, M.; Okabayashi, T. Duodenojejunostomy for endoscopic management of biliary enteric anastomotic stricture inaccessible via balloon-assisted endoscopy: A case report. *Surg. Case Rep.* **2023**, *9*, 82. [[CrossRef](#)] [[PubMed](#)]
13. Sakamoto, S.; Tabuchi, M.; Okamoto, N.; Yoshimatsu, R.; Matsumoto, M.; Iwata, J.; Iiyama, T.; Okabayashi, T. The Clinical Features of Late Postoperative Cholangitis After Hepaticojejunostomy Brought on by Conditions other than Cancer Recurrence. *Am. Surg.* **2024**, *90*, 800–809. [[CrossRef](#)] [[PubMed](#)]
14. Lillemoe, K.D.; Melton, G.B.; Cameron, J.L.; Pitt, H.A.; Campbell, K.A.; Talamini, M.A.; Sauter, P.A.; Coleman, J.; Yeo, C.J. Postoperative bile duct strictures: Management and outcome in the 1990s. *Ann. Surg.* **2000**, *232*, 430–441. [[CrossRef](#)] [[PubMed](#)]
15. Schreuder, A.M.; Nunez Vas, B.C.; Booi, K.A.C.; van Dieren, S.; Besselink, M.G.; Busch, O.R.; van Gulik, T.M. Optimal timing for surgical reconstruction of bile duct injury: Meta-analysis. *BJS Open* **2020**, *4*, 776–786. [[CrossRef](#)] [[PubMed](#)]
16. Neuhaus, P.; Jonas, S.; Bechstein, W.O.; Lohmann, R.; Radke, C.; Kling, N.; Wex, C.; Lobeck, H.; Hintze, R. Extended resections for hilar cholangiocarcinoma. *Ann. Surg.* **1999**, *230*, 808–818; discussion 819. [[CrossRef](#)] [[PubMed](#)]
17. Schreuder, A.M.; Busch, O.R.; Besselink, M.G.; Ignatavicius, P.; Gulbinas, A.; Barauskas, G.; Gouma, D.J.; van Gulik, T.M. Long-Term Impact of Iatrogenic Bile Duct Injury. *Dig. Surg.* **2020**, *37*, 10–21. [[CrossRef](#)] [[PubMed](#)]
18. Pitt, H.A.; Miyamoto, T.; Parapatis, S.K.; Tompkins, R.K.; Longmire, W.P., Jr. Factors influencing outcome in patients with postoperative biliary strictures. *Am. J. Surg.* **1982**, *144*, 14–21. [[CrossRef](#)] [[PubMed](#)]

19. Omar, M.A.; Kamal, A.; Redwan, A.A.; Alansary, M.N.; Ahmed, E.A. Post-cholecystectomy major bile duct injury: Ideal time to repair based on a multicentre randomized controlled trial with promising results. *Int. J. Surg.* **2023**, *109*, 1208–1221. [[CrossRef](#)] [[PubMed](#)]
20. American Society for Gastrointestinal Endoscopy Standards of Practice Committee; Marya, N.B.; Pawa, S.; Thiruvengadam, N.R.; Ngamruengphong, S.; Baron, T.H.; Bun Teoh, A.Y.; Bent, C.K.; Abidi, W.; Alipour, O.; et al. American Society for Gastrointestinal Endoscopy guideline on the role of therapeutic EUS in the management of biliary tract disorders: Methodology and review of evidence. *Gastrointest. Endosc.* **2024**, *100*, e79–e135. [[CrossRef](#)] [[PubMed](#)]
21. Dumonceau, J.M.; Tringali, A.; Papanikolaou, I.S.; Blero, D.; Mangiavillano, B.; Schmidt, A.; Vanbiervliet, G.; Costamagna, G.; Devière, J.; García-Cano, J.; et al. Endoscopic biliary stenting: Indications, choice of stents, and results: European Society of Gastrointestinal Endoscopy (ESGE) Clinical Guideline—Updated October 2017. *Endoscopy* **2018**, *50*, 910–930. [[CrossRef](#)] [[PubMed](#)]
22. Tomoda, T.; Kato, H.; Ueki, T.; Ogawa, T.; Hirao, K.; Akimoto, Y.; Matsumoto, K.; Horiguchi, S.; Tsutsumi, K.; Okada, H. Efficacy of double-balloon enteroscopy-assisted endoscopic balloon dilatation combined with stent deployment for hepaticojejunostomy anastomotic stricture. *Dig. Endosc.* **2022**, *34*, 604–611. [[CrossRef](#)] [[PubMed](#)]
23. Huszár, O.; Kokas, B.; Mátrai, P.; Hegyi, P.; Pétervári, E.; Vincze, Á.; Pár, G.; Sarlós, P.; Bajor, J.; Czimmer, J.; et al. Meta-Analysis of the Long Term Success Rate of Different Interventions in Benign Biliary Strictures. *PLoS ONE* **2017**, *12*, e0169618. [[CrossRef](#)] [[PubMed](#)]
24. Schumacher, B.; Othman, T.; Jansen, M.; Preiss, C.; Neuhaus, H. Long-term follow-up of percutaneous transhepatic therapy (PTT) in patients with definite benign anastomotic strictures after hepaticojejunostomy. *Endoscopy* **2001**, *33*, 409–415. [[CrossRef](#)] [[PubMed](#)]
25. ASGE Standards of Practice Committee; Pawa, S.; Marya, N.B.; Thiruvengadam, N.R.; Ngamruengphong, S.; Baron, T.H.; Bun Teoh, A.Y.; Bent, C.K.; Abidi, W.; Alipour, O.; et al. American Society for Gastrointestinal Endoscopy guideline on the role of therapeutic EUS in the management of biliary tract disorders: Summary and recommendations. *Gastrointest. Endosc.* **2024**, *100*, 967–979. [[CrossRef](#)] [[PubMed](#)]
26. van Wanrooij, R.L.J.; Bronswijk, M.; Kunda, R.; Everett, S.M.; Lakhtakia, S.; Rimbass, M.; Hucl, T.; Badaoui, A.; Law, R.; Arcidiacono, P.G.; et al. Therapeutic endoscopic ultrasound: European Society of Gastrointestinal Endoscopy (ESGE) Technical Review. *Endoscopy* **2022**, *54*, 310–332. [[CrossRef](#)] [[PubMed](#)]
27. Walsh, R.M.; Vogt, D.P.; Ponsky, J.L.; Brown, N.; Mascha, E.; Henderson, J.M. Management of failed biliary repairs for major bile duct injuries after laparoscopic cholecystectomy. *J. Am. Coll. Surg.* **2004**, *199*, 192–197. [[CrossRef](#)] [[PubMed](#)]
28. Crinò, S.F.; Aabakken, L.; Bapaye, A.; Chan, S.; Kida, M.; Law, R.; Maluf-Filho, F.; Mekaroonkamol, P.; de Moura, E.G.H.; Bestetti, A.; et al. World Endoscopy Organization guidelines on endoscopic retrograde cholangiopancreatography biliary cannulation and sphincterotomy techniques. *Dig. Endosc.* **2025**, *37*, 1029–1053. [[CrossRef](#)] [[PubMed](#)]
29. Pennazio, M.; Rondonotti, E.; Despott, E.J.; Dray, X.; Keuchel, M.; Moreels, T.; Sanders, D.S.; Spada, C.; Carretero, C.; Cortegoso Valdivia, P.; et al. Small-bowel capsule endoscopy and device-assisted enteroscopy for diagnosis and treatment of small-bowel disorders: European Society of Gastrointestinal Endoscopy (ESGE) Guideline—Update 2022. *Endoscopy* **2023**, *55*, 58–95. [[CrossRef](#)] [[PubMed](#)]
30. Maier, E.; Stättner, S.; Carrion-Alvarez, L.; Di Martino, M.; Olthof, P.; Primavesi, F.; Sochorova, D.; van Laarhoven, S.; Balakrishnan, A.; Breikopf, R.; et al. The E-AHPBA-ESSO-Innsbruck consensus recommendations on peri- and postoperative management following liver resection. *Br. J. Surg.* **2025**, *113*, znaf272. [[CrossRef](#)] [[PubMed](#)]
31. Tanisaka, Y.; Ryozaawa, S.; Mizuide, M.; Araki, R.; Fujita, A.; Ogawa, T.; Tashima, T.; Noguchi, T.; Suzuki, M.; Katsuda, H. Status of single-balloon enteroscopy-assisted endoscopic retrograde cholangiopancreatography in patients with surgically altered anatomy: Systematic review and meta-analysis on biliary interventions. *Dig. Endosc.* **2021**, *33*, 1034–1044. [[CrossRef](#)] [[PubMed](#)]
32. Neuhaus, P.; Thelen, A. Radical surgery for right-sided klatskin tumor. *HPB* **2008**, *10*, 171–173. [[CrossRef](#)] [[PubMed](#)]
33. Amateau, S.K.; Kohli, D.R.; Desai, M.; Chinnakotla, S.; Harrison, M.E.; Chalhoub, J.M.; Coelho-Prabhu, N.; Elhanafi, S.E.; Forbes, N.; Fujii-Lau, L.L.; et al. American Society for Gastrointestinal Endoscopy guideline on management of post-liver transplant biliary strictures: Methodology and review of evidence. *Gastrointest. Endosc.* **2023**, *97*, 615–637.e11. [[CrossRef](#)] [[PubMed](#)]
34. Dumonceau, J.M.; Kapral, C.; Aabakken, L.; Papanikolaou, I.S.; Tringali, A.; Vanbiervliet, G.; Beyna, T.; Dinis-Ribeiro, M.; Hritz, I.; Mariani, A.; et al. ERCP-related adverse events: European Society of Gastrointestinal Endoscopy (ESGE) Guideline. *Endoscopy* **2020**, *52*, 127–149. [[CrossRef](#)] [[PubMed](#)]
35. Felder, S.I.; Menon, V.G.; Nissen, N.N.; Margulies, D.R.; Lo, S.; Colquhoun, S.D. Hepaticojejunostomy using short-limb Roux-en-Y reconstruction. *JAMA Surg.* **2013**, *148*, 253–257; discussion 257–258. [[CrossRef](#)] [[PubMed](#)]
36. Al-Ghnnaniem, R.; Benjamin, I.S. Long-term outcome of hepaticojejunostomy with routine access loop formation following iatrogenic bile duct injury. *Br. J. Surg.* **2002**, *89*, 1118–1124. [[CrossRef](#)] [[PubMed](#)]
37. Yang, M.J.; Cho, W.; Hwang, J.C.; Yoo, B.M.; Kim, S.S.; Kim, J.H.; Shin, E.J. Mechanistic loop-resolution strategies for short-type single-balloon enteroscopy-assisted ERCP in patients post Roux-en-Y hepaticojejunostomy with a preserved stomach and duodenum. *Endoscopy* **2025**, *57*, 1386–1393. [[CrossRef](#)] [[PubMed](#)]

38. James, T.W.; Fan, Y.C.; Baron, T.H. EUS-guided hepaticoenterostomy as a portal to allow definitive antegrade treatment of benign biliary diseases in patients with surgically altered anatomy. *Gastrointest. Endosc.* **2018**, *88*, 547–554. [[CrossRef](#)] [[PubMed](#)]
39. Ramesh, H.; Prakash, K.; Kuruvilla, K.; Philip, M.; Jacob, G.; Venugopal, B.; Lekha, V.; Varma, D. Biliary access loops for intrahepatic stones: Results of jejunoduodenal anastomosis. *ANZ J. Surg.* **2003**, *73*, 306–312. [[CrossRef](#)] [[PubMed](#)]
40. Matsumoto, K.; Kato, H.; Matsumi, A.; Miyamoto, K.; Morimoto, K.; Fujii, Y.; Sato, R.; Hattori, N.; Obata, T.; Terasawa, H.; et al. Detection of residual stones by peroral direct cholangioscopy in patients with intrahepatic stones after hepaticojejunostomy: A prospective study (with video). *Gastrointest. Endosc.* **2024**, *100*, 457–463. [[CrossRef](#)] [[PubMed](#)]
41. Raafat, M.; Morsy, M.M.; Mohamed, S.I.; Hamad, M.A.; Sayed, M.M. Hepaticojejunostomy with gastric access loop versus conventional hepaticojejunostomy: A randomized trial. *Updates Surg.* **2023**, *75*, 2157–2167. [[CrossRef](#)] [[PubMed](#)]
42. Testoni, P.A.; Mariani, A.; Aabakken, L.; Arvanitakis, M.; Bories, E.; Costamagna, G.; Devière, J.; Dinis-Ribeiro, M.; Dumonceau, J.M.; Giovannini, M.; et al. Papillary cannulation and sphincterotomy techniques at ERCP: European Society of Gastrointestinal Endoscopy (ESGE) Clinical Guideline. *Endoscopy* **2016**, *48*, 657–683. [[CrossRef](#)] [[PubMed](#)]
43. Bonomi, A.; Overvest, A.G.; Busch, O.R.; Kazemier, G.; Zonderhuis, B.M.; Erdmann, J.I.; Danelli, P.; van Wanrooij, R.L.J.; Verdonk, R.C.; Besselink, M.G.; et al. Towards a ‘step-up approach’ for the treatment of recurrent non-stenotic cholangitis after hepaticojejunostomy: Systematic review. *HPB* **2024**, *26*, 1114–1122. [[CrossRef](#)] [[PubMed](#)]
44. Iglesias, N.; Huerta, C.T.; Lynn, R.; Perez, E.A. Biliary Reconstruction with Hepaticoduodenostomy Versus Hepaticojejunostomy After Choledochal Cyst Resection: A Narrative Review. *J. Clin. Med.* **2024**, *13*, 6556. [[CrossRef](#)] [[PubMed](#)]
45. Narayanan, S.K.; Chen, Y.; Narasimhan, K.L.; Cohen, R.C. Hepaticoduodenostomy versus hepaticojejunostomy after resection of choledochal cyst: A systematic review and meta-analysis. *J. Pediatr. Surg.* **2013**, *48*, 2336–2342. [[CrossRef](#)] [[PubMed](#)]
46. Birgin, E.; Téoule, P.; Galata, C.; Rahbari, N.N.; Reissfelder, C. Cholangitis following biliary-enteric anastomosis: A systematic review and meta-analysis. *Pancreatology* **2020**, *20*, 736–745. [[CrossRef](#)] [[PubMed](#)]
47. Todani, T.; Watanabe, Y.; Mizuguchi, T.; Fujii, T.; Toki, A. Hepaticoduodenostomy at the hepatic hilum after excision of choledochal cyst. *Am. J. Surg.* **1981**, *142*, 584–587. [[CrossRef](#)] [[PubMed](#)]
48. Chuang, J.H.; Lee, S.Y.; Shieh, C.S.; Chen, W.J.; Chang, N.K. Reappraisal of the role of the bilioenteric conduit in the pathogenesis of postoperative cholangitis. *Pediatr. Surg. Int.* **2000**, *16*, 29–34. [[CrossRef](#)] [[PubMed](#)]
49. Sevcik, J.; Massaro, M.S.; Palek, R.; Moulisova, V.; Liska, V. Anatomical biliary reconstruction as an ultimatum refugium for selective cases—History and current state of knowledge. *J. Hepatobiliary Pancreat. Sci.* **2024**, *31*, 769–781. [[CrossRef](#)] [[PubMed](#)]
50. Ai, C.; Wu, Y.; Xie, X.; Wang, Q.; Xiang, B. Roux-en-Y hepaticojejunostomy or hepaticoduodenostomy for biliary reconstruction after resection of congenital biliary dilatation: A systematic review and meta-analysis. *Surg. Today* **2023**, *53*, 1–11. [[CrossRef](#)] [[PubMed](#)]
51. Hamad, M.A.; El-Amin, H. Bilio-entero-gastrostomy: Prospective assessment of a modified biliary reconstruction with facilitated future endoscopic access. *BMC Surg.* **2012**, *12*, 9. [[CrossRef](#)] [[PubMed](#)]

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