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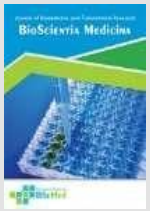

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Autologous Parietal Peritoneum as a Biliary Interposition Conduit for Complex Post-Cholecystectomy Bile Duct Injuries: A Feasibility Study and Report of Two Cases

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A B S T R A C T

Background: Complex iatrogenic bile duct injuries (BDIs) are formidable surgical challenges, with Roux-en-Y hepaticojejunostomy (RYHJ) being the standard reconstruction. However, RYHJ permanently alters gastrointestinal physiology and is associated with significant long-term morbidity. This has prompted a search for physiology-preserving alternatives. We describe a novel technique using a tubularized autologous parietal peritoneal graft for biliary reconstruction. **Case presentation:** This report details the successful management of two patients with high-grade, post-cholecystectomy BDIs (Strasberg-Bismuth Type E1 and E3). Both patients presented with obstructive jaundice and controlled biliary fistulae. Definitive single-stage reconstruction was performed. A segment of parietal peritoneum was harvested, tubularized over a T-tube to create an interposition conduit, and anastomosed to bridge the biliary defect. The repair was reinforced with a pedicled omental flap. Both patients demonstrated complete resolution of jaundice and normalization of liver function tests, with radiological evidence of graft patency and no stricture at 12-month follow-up. **Conclusion:** This preliminary experience in two patients suggests that the use of a tubularized autologous parietal peritoneal graft is a surgically feasible technique for the reconstruction of complex BDIs. This approach offers a potential physiology-preserving alternative to traditional bilioenteric anastomosis. Its safety, efficacy, and long-term durability remain unknown and require rigorous evaluation in larger prospective studies.

1. Introduction

Cholecystectomy is the definitive treatment for symptomatic cholelithiasis and stands as one of the most common abdominal surgical procedures performed globally. Despite continuous refinements in surgical technique and perioperative imaging, iatrogenic bile duct injury (BDI) persists as a devastating complication.[1] The incidence is reported between 0.1-0.3% for open cholecystectomy and rises to 0.3-0.6% for the laparoscopic approach, the latter of which has seen an increased incidence since its widespread adoption. The consequences of a BDI are profound, leading to a cascade of patient morbidity, including biliary fistula, cholangitis, secondary biliary cirrhosis, and a mortality rate that can approach 3.5%.[2] The majority of injuries are not recognized intraoperatively, with patients often presenting postoperatively with non-specific symptoms that delay diagnosis and management.[3] Optimal outcomes are strongly correlated with prompt referral to high-volume, specialized hepatobiliary centers where experienced multidisciplinary teams can orchestrate management.[4]

The management of BDI is dictated by the injury's anatomical location, extent, and the patient's clinical stability, often classified using the Strasberg-Bismuth system.[5] While minor bile leaks (Strasberg Type A) are often amenable to endoscopic or percutaneous management, complex injuries involving complete transection or excision of a major bile duct (Strasberg Type E) invariably require surgical reconstruction. For these high-grade injuries, the Roux-en-Y hepaticojejunostomy (RYHJ) is the established gold standard.[6] This procedure involves the creation of a tension-free, mucosa-to-mucosa anastomosis between the proximal healthy biliary stump and a defunctionalized Roux limb of jejunum. In expert hands, RYHJ yields high success rates, with long-term patency reported to exceed 90%.

However, the RYHJ is not a panacea. The procedure fundamentally and permanently alters the native gastrointestinal architecture. By diverting bile flow directly into the jejunum, it bypasses the sphincter of Oddi, a critical regulator of bile flow and a barrier against ascending contamination from the gut. This physiological disruption can precipitate a host of debilitating long-term complications, including reflux cholangitis, anastomotic stricture, and sump syndrome.[7] Furthermore, the bilioenteric anastomosis renders the biliary tree inaccessible to future endoscopic retrograde cholangiopancreatography (ERCP), complicating the management of any subsequent biliary pathology.

These significant drawbacks have fueled a persistent search for alternative reconstructive techniques that can restore biliary continuity while preserving the native anatomical pathway—a true "duct-to-duct" repair.[8] The ideal graft material for such a repair must be readily available, non-immunogenic, resistant to the corrosive effects of bile, and capable of promoting tissue regeneration without inducing a fibrotic stricture. While synthetic grafts have been largely abandoned due to high rates of infection and foreign body reaction, various autologous tissues—including vein segments, falciform ligament, and omentum—have been explored, primarily as onlay patches for partial defects rather than as complete circumferential conduits.

The parietal peritoneum represents a uniquely promising, yet underexplored, candidate for this purpose. Far from being an inert membrane, the peritoneum is a dynamic, mesodermally-derived serous membrane with remarkable regenerative potential. Its surface is lined by a single layer of mesothelial cells, which are now understood to possess pluripotent capabilities, allowing them to undergo transdifferentiation to facilitate tissue repair and regeneration. The peritoneum has a rich microvascular and lymphatic supply, is inherently pro-angiogenic, and possesses immunomodulatory properties that may mitigate the excessive fibrotic response that leads to stricture.[9] It is also readily available in large quantities within the same surgical field, obviating any donor site morbidity. Preliminary animal studies have supported this potential, demonstrating that peritoneal grafts can integrate and remodel into functional biliary conduits without significant stricture formation.

Despite these compelling biological attributes and supportive preclinical data, the clinical application of autologous parietal peritoneum for the reconstruction of complex, complete bile duct transections in humans remains largely unexplored.[10] The novelty of this study lies in providing the first detailed description of a surgical technique using a tubularized autologous parietal peritoneal graft as a complete interposition conduit for repairing high-grade, post-cholecystectomy Strasberg Type E injuries. The aim of this report is to describe our surgical technique in detail and to present the clinical, biochemical, and radiological outcomes from our initial experience with two patients, thereby demonstrating the feasibility of this innovative, physiology-preserving approach to biliary reconstruction.

2. Case Presentation

This report, prepared in accordance with CARE guidelines, details the cases of two consecutive patients who underwent reconstruction for complex

BDIs at our tertiary hepatobiliary unit. Informed consent was obtained from both patients for the publication of their case details.

Case 1

A 54-year-old female was referred to our institution from a regional hospital four days after undergoing an open cholecystectomy for symptomatic cholelithiasis. She presented with a constellation of symptoms, including worsening epigastric pain, fever (38.6°C), and rapidly progressing jaundice. Her past medical history was non-contributory. The operative note from the referring hospital described a difficult dissection secondary to severe inflammation in Calot's triangle. On admission, she was tachycardic (108 beats/minute) but hemodynamically stable. Physical examination was notable for deep scleral icterus and marked tenderness in the right upper quadrant. A surgical drain placed during the initial operation was draining approximately 150 mL of dark, bilious fluid daily.

Table 1. Summary of clinical findings of case 1.

PATIENT DATA POINT		FINDING / VALUE
Patient Demographics & History		
Age		54 years
Sex		Female
Previous Surgery		Open Cholecystectomy for Symptomatic Cholelithiasis
Time to Presentation		4 days post-initial surgery
Clinical Presentation on Admission		
Primary Symptoms		Progressive Jaundice, Worsening Epigastric Pain, Fever
Vital Signs		• **Temperature:** 38.6°C • **Heart Rate:** 108 bpm • **Blood Pressure:** 110/70 mmHg
Physical Examination Findings		• Deep Scleral Icterus • Marked Right Upper Quadrant (RUQ) Tenderness
Surgical Drain Output		Approx. 150 cc / 24 hours (dark, bilious fluid)
Key Laboratory Findings (on admission)	**Reference Range**	**Value**
Leukocytes	4.5–11.0 (10^3/µL)	13.3
Total Bilirubin	0.2–1.2 (mg/dL)	14.80
Direct Bilirubin	0.0–0.4 (mg/dL)	7.79
SGPT / ALT	< 40 (U/L)	133
Alkaline Phosphatase	44–147 (U/L)	450
Albumin	3.5–5.2 (g/dL)	2.7
Diagnostic Imaging & Final Diagnosis		
Imaging Modality		Endoscopic Retrograde Cholangiopancreatography (ERCP)
ERCP Findings		• Complete occlusion (cut-off) of the Common Hepatic Duct (CHD) • Active extravasation of contrast into perihepatic space • Normal distal Common Bile Duct (CBD)
Final Diagnosis		**Strasberg-Bismuth Type E1 Bile Duct Injury**

Table 2. Longitudinal laboratory results of case 1.

Tracking Biochemical Recovery from Baseline to 12-Month Follow-up

PARAMETER	REFERENCE RANGE	PRE-CHOLECYSTECTOMY (BASELINE)	ON ADMISSION TO TERTIARY CENTER	POST-RECONSTRUCTION (DAY 7)	12-MONTH FOLLOW-UP
Leukocytes (10^3/µL)	4.5–11.0	8.2	13.3	9.5	6.8
Total Bilirubin (mg/dL)	0.2–1.2	0.76	14.80	5.12	0.9
Direct Bilirubin (mg/dL)	0.0–0.4	0.21	7.79	2.80	0.3
SGOT / AST (U/L)	< 40	25	90	45	17
SGPT / ALT (U/L)	< 40	31	133	68	19
Alkaline Phosphatase (U/L)	44–147	88	450	210	95
Albumin (g/dL)	3.5–5.2	4.1	2.7	3.2	4.3

Critical Value Improving / Abnormal Normal / Resolved

Diagnostic assessment and timeline of patient 1 were presented in Figure 1. (1) Day 0 (at referring hospital): Underwent open cholecystectomy. Preoperative total bilirubin was normal at 0.76 mg/dL; (2) Day 4: Referred to our tertiary center with obstructive jaundice. Initial laboratory tests revealed leukocytosis (13.3 x 10^3/µL), severe conjugated hyperbilirubinemia (Total Bilirubin 14.80 mg/dL, Direct 7.79 mg/dL), elevated transaminases (AST 90 U/L, ALT 133 U/L), and hypoalbuminemia (2.7 g/dL), indicative of severe cholestasis and a systemic inflammatory response (Table 2); (3) Day 5: An urgent ERCP was performed. The cholangiogram demonstrated a complete, sharp cut-off of the common hepatic duct (CHD) approximately 2.5 cm below the biliary confluence, with active contrast extravasation into the perihepatic space, confirming a complete transection. The distal common bile duct (CBD) was normal. The injury was classified as a Strasberg-Bismuth Type E1 BDI. A 7 French, 9 cm plastic biliary stent was placed up to the point of occlusion to serve as a landmark during subsequent surgery; it provided no drainage function. (4) Day 6-10: The patient was stabilized with broad-spectrum intravenous antibiotics and nutritional support, including albumin supplementation, to optimize her for definitive repair; (5) Day 11: Definitive surgical reconstruction was performed (Figure 1). Details of the surgical technique are provided in Figure 2. In summary, a 1.5 cm gap in the CHD was bridged using a tubularized autologous parietal peritoneal graft, with the repair reinforced by a pedicled omental flap.

Figure 1. Case 1 timeline and diagnostics.

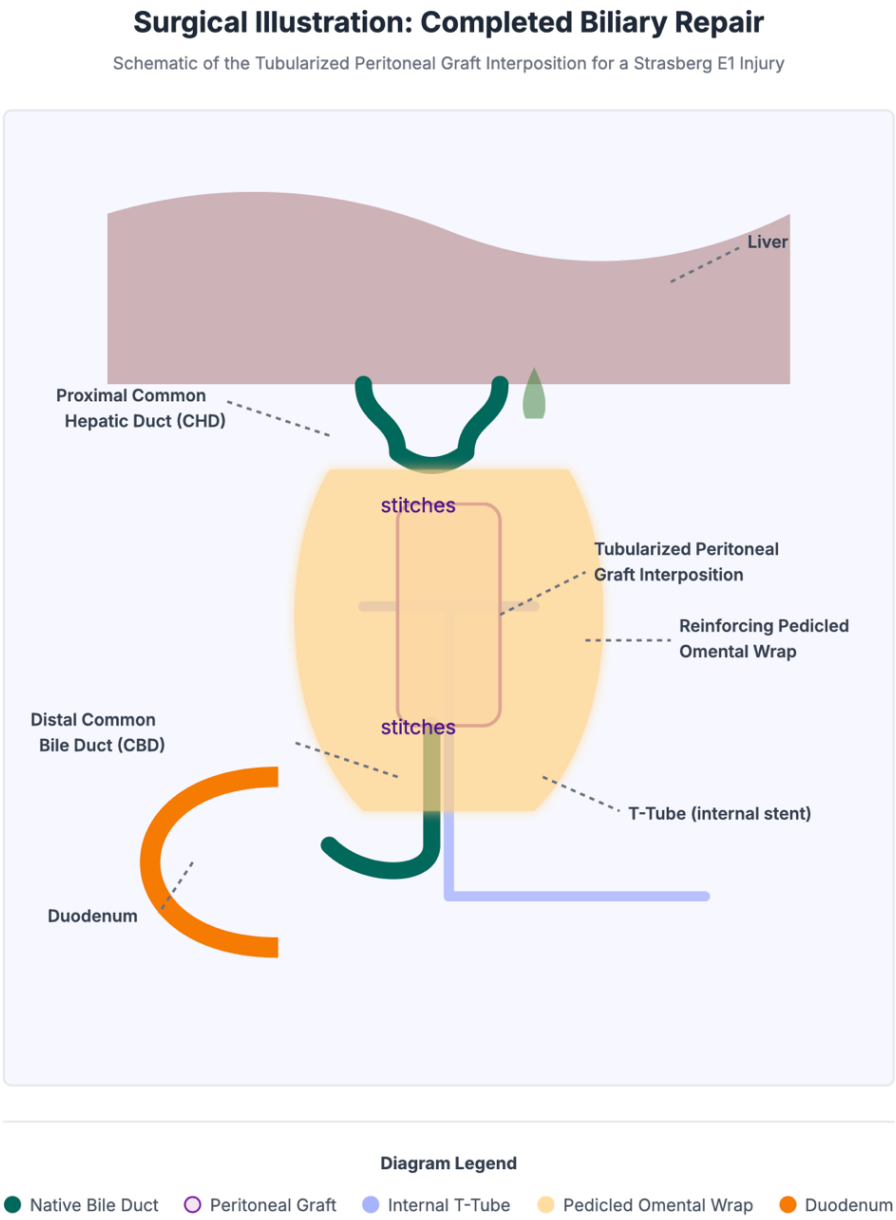

Figure 2. Surgical diagram of case 1. Schematic illustration of the completed repair, showing the tubularized peritoneal graft interposed between the CHD and CBD, with the reinforcing pedicled omental wrap covering both anastomoses.

In the postoperative course and follow-up, the patient was monitored in a high-dependency unit for 48 hours. The abdominal drains had an initial bilious output of approximately 150 mL/day, which gradually decreased and became serous by postoperative day 6. She was discharged on day 7. She developed a minor superficial wound dehiscence (<5 cm), likely exacerbated by her preoperative hypoalbuminemia, which was managed conservatively with regular dressings. The drains were removed at 12 days post-discharge. The T-tube was clamped at 4 weeks and removed at 6 weeks following a normal T-tube cholangiogram. At the 3 and 12-month follow-up, the patient was asymptomatic and anicteric. Her liver function tests had completely normalized (Table 2). A 12-month follow-up MRCP confirmed a patent reconstruction without stricture. The patient reported an excellent quality of life at her 12-month review,

having returned to all her normal daily activities without any pain or dietary restrictions.

Case 2

A 44-year-old female with a history of well-controlled hypertension was transferred to our center five days after a laparotomic cholecystectomy at an outside facility. She presented with high-grade fever (39.1°C), severe right upper quadrant pain, and profound jaundice, consistent with biliary sepsis. A surgical drain was in place, with a high daily output of over 200 mL of bile. On examination, she was tachycardic (115 beats/minute) and febrile, with deep scleral icterus and diffuse upper abdominal tenderness, suggesting biliary peritonitis (Table 3).

Table 3. Summary of clinical findings: Case 2.

A Comprehensive Overview of the Patient's Presentation, Diagnosis, and Outcome

Patient Profile	
Age & Gender	44-year-old female
Relevant Medical History	Well-controlled hypertension. No prior history of liver disease or biliary surgery.
Initial Procedure	Laparotomic cholecystectomy at an outside institution, performed 5 days prior to transfer.
Clinical Presentation on Admission	
Chief Complaints	Severe right upper quadrant pain, high-grade fever, and rapidly deepening jaundice.
Vital Signs & Physical Exam	• **Fever:** 39.1°C • **Tachycardia:** 115 beats/minute • Profound scleral icterus • Diffuse tenderness across the entire upper abdomen
Surgical Drain Output	High volume, with >200 cc/day of bilious fluid.
Working Diagnosis	**Biliary peritonitis and sepsis** secondary to a major iatrogenic bile duct injury.
Diagnostic Workup	
Key Laboratory Findings	• **Leukocytes:** 16.3 × 10^3/µL (Marked inflammatory response) • **Total Bilirubin:** 17.80 mg/dL (Severe cholestasis) • **Albumin:** 2.5 g/dL (Significant hypoalbuminemia)
ERCP Findings	Revealed a **complete cut-off of contrast at the biliary confluence**. Neither the right nor left hepatic duct could be visualized.
MRCP Findings	Confirmed the transection at the confluence, revealing moderately dilated intrahepatic ducts and a **defect gap of approximately 1.8 cm**.
Final Diagnosis & Outcome	
Final Injury Classification	**Strasberg-Bismuth Type E3 Bile Duct Injury**
Intervention	Definitive single-stage surgical reconstruction using a tubularized autologous parietal peritoneal graft with a reinforcing pedicled omental wrap.
12-Month Follow-up	• Completely asymptomatic with normalized liver function tests. • Follow-up MRCP confirmed a successful, widely patent reconstruction. • No evidence of stricture, biliary lithiasis, or graft failure.
Patient-Reported Outcome	Expressed high satisfaction with recovery, reporting a full return to baseline activities with no pain or digestive issues.

The patient's diagnostic and preoperative course began upon her transfer to our tertiary center on the fifth day following her initial cholecystectomy. Her precarious clinical state necessitated an immediate and thorough investigation. Initial laboratory investigations painted a stark picture of a patient in distress, revealing a pronounced systemic inflammatory response evidenced by a significant leukocytosis of 16.3 x 10^3/µL. Concurrently, severe cholestasis was confirmed by a total bilirubin level that had escalated to 17.80 mg/dL, a dramatic increase from her normal preoperative baseline of 0.40 mg/dL. Critically, her serum albumin was profoundly low at 2.5 g/dL, indicating a state of significant malnutrition and systemic stress that would have important implications for wound healing and recovery (Table 4). With this biochemical evidence in hand, urgent radiological evaluation was pursued on the sixth day. An endoscopic retrograde cholangiopancreatography (ERCP) was performed, which unequivocally identified the site of the injury. The cholangiogram demonstrated a complete and abrupt cut-off of contrast precisely at the level of the biliary confluence, with a stark inability to visualize either the right or left hepatic ducts. This finding was pathognomonic for a high-grade hilar injury, which was immediately classified as a Strasberg-Bismuth Type E3 Bile Duct Injury. To aid in the subsequent operation, a landmark stent was placed at the site of the injury. To further refine the surgical strategy, a Magnetic Resonance Cholangiopancreatography (MRCP) was also performed. This advanced imaging modality provided crucial anatomical detail, confirming the transection at the confluence and revealing moderately dilated intrahepatic ducts upstream of the obstruction. Importantly, the MRCP allowed for a precise measurement of the defect, quantifying the gap between the transected ends at approximately 1.8 cm.

Table 4. Laboratory results of case 2.

A Chronological Overview of the Patient's Biochemical Recovery

PARAMETER (UNITS)	PRE-CHOLECYSTECTOMY (BASELINE)	ON ADMISSION TO TERTIARY CENTER	POST-RECONSTRUCTION DAY 7	12-MONTH FOLLOW-UP
Leukocytes (10^3/µL)	7.5	↗ 16.3	↘ 10.1	✓ 7.1
Total Bilirubin (mg/dL)	0.40	↗ 17.80	↘ 6.2	✓ 0.8
Direct Bilirubin (mg/dL)	0.15	↗ 8.69	↘ 3.5	✓ 0.2
SGOT / AST (U/L)	22	↗ 96	↘ 52	✓ 20
SGPT / ALT (U/L)	28	↗ 142	↘ 75	✓ 22
Alkaline Phosphatase (U/L)	92	↗ 510	↘ 250	✓ 102
Albumin (g/dL)	4.2	↘ 2.5	↗ 3.0	✓ 4.1

Status Legend

(!) Acutely Abnormal Value ↘ Improving / Resolving ✓ Normalized / Within Range

Following this definitive diagnosis, the patient entered a prolonged and critical period of preoperative optimization spanning from day seven to day twelve. Given her presentation with biliary peritonitis and sepsis, immediate surgery was contraindicated. Instead, she underwent aggressive resuscitation and stabilization. This multi-faceted approach involved the administration of broad-spectrum intravenous antibiotics to control the septic process, intensive nutritional support to correct her severe hypoalbuminemia, and diligent management of her overall physiological state. Only after this crucial period of stabilization, once the septic process was controlled and she was deemed medically fit for a major reconstructive procedure, was she taken for definitive surgical reconstruction on the thirteenth day. The 1.8 cm hilar defect was repaired using a tubularized peritoneal graft, spatulating the proximal end to create a wide anastomosis to the confluence (hepatico-peritoneostomy).

The patient's initial postoperative course was similar to Case 1, with a controlled bile leak from the drains that resolved over the first week. She was discharged on postoperative day 9. Her abdominal drains were removed 14 days post-discharge, and her T-tube was removed at 6 weeks after a normal cholangiogram. At her 3 and 12-month follow-up visits, she was completely asymptomatic with fully normalized liver function tests (Table 4). The 12-month MRCP confirmed a successful, widely patent reconstruction without any evidence of stricture or biliary lithiasis. At one year, the patient expressed high satisfaction with her recovery, reporting no abdominal pain or digestive issues and a full return to her baseline activities.

Following a period of intensive resuscitation and physiological optimization, both patients were brought to the operating theater for definitive surgical reconstruction. The core surgical strategy was identical for both, predicated on the principles of meticulous dissection, tension-free anastomosis, and vascularized tissue reinforcement. The procedure unfolded as a sequence of deliberate, carefully executed steps designed to bridge the biliary defect while preserving native anatomy.

The operation commenced with a midline laparotomy, extending the previous incision to ensure adequate exposure of the upper abdomen. Upon entering the peritoneal cavity, the surgical field was immediately recognized as hostile—a direct consequence of the initial bile leak and the subsequent inflammatory cascade. The subhepatic space, normally a well-defined anatomical region, was obscured by a dense, vascularized inflammatory tissue, often referred to as a "phlegmon." Adhesions fused the liver, duodenum, and transverse colon into a cohesive mass. The first critical phase of the operation was a meticulous and patient adhesiolysis. Using a combination of sharp and blunt dissection, the plane between the visceral surface of the liver and the surrounding structures was gradually developed. The previously placed surgical drain served as a valuable landmark, guiding the dissection toward a contained biloma, which was carefully entered, and its contents evacuated and sent for culture. This step was paramount not only for exposure but also for clearing the septic focus. The dissection proceeded methodically to delineate the anatomy of the porta hepatis. The common bile duct, hepatic artery, and portal vein were identified distally, in a region of relatively normal tissue, and then traced proximally into the scarred inflammatory mass. The site of the bile duct injury was finally identified as a complete transection, with the proximal and distal stumps retracted and separated by a fibrotic gap. The endoscopically placed landmark stent was visualized within the lumen of the distal stump, confirming the level of injury with absolute certainty. The final step in preparing the ductal ends was a meticulous debridement. The scarred, fibrotic, and poorly vascularized edges of both stumps were excised back to healthy, pliable tissue, evidenced by punctate bleeding from the cut edges. This aggressive debridement is a cornerstone of successful biliary reconstruction, as anastomosing to ischemic tissue is a primary cause of subsequent stricture formation.

With the biliary defect fully defined, attention turned to harvesting the autologous graft. A segment of parietal peritoneum was harvested from the anterior abdominal wall, well lateral to the midline incision. A crucial technical point is the inclusion of the underlying transversalis fascia with the peritoneal layer. The peritoneum alone is too delicate and lacks the necessary tensile strength to function as a conduit; the transversalis fascia provides the essential structural integrity to prevent suture pull-through, early dissolution, and potential late aneurysmal dilatation. A rectangle of tissue, measuring approximately 2.5 cm by 2.0 cm, was incised and carefully elevated off the underlying musculature. This dissection was performed with precision to preserve the rich microvascular plexus within the graft, which, while not a pedicled supply, is vital for its initial survival before neovascularization occurs.

The harvested graft was then prepared on the back table. It was laid flat with its smooth, glistening mesothelial surface oriented to become the luminal surface of the new conduit. The rationale for this orientation is twofold: biologically, the mesothelium provides a pro-reparative, non-thrombogenic surface that is thought to facilitate the migration and proliferation of native cholangiocytes from the ductal stumps; and mechanically, the fascial side provides a better surface for holding sutures. The graft was then tubularized around a 14 French T-tube, which served as both a temporary internal stent to maintain luminal patency and as a scaffold to define the conduit's shape and diameter. This size was chosen to approximate the diameter of a healthy common hepatic duct. The longitudinal seam of the newly formed tube was meticulously closed with a continuous 6-0 polydioxanone (PDS) absorbable suture, creating a waterproof seal.

The completed peritoneal conduit was then brought into the operative field for interposition. The anastomoses were performed in a tension-free manner, which is critical to prevent ischemia and leakage. The nature of the proximal anastomosis was tailored to the specific injury. In Patient 1, with a Strasberg E1 injury leaving a sufficient length of common hepatic duct, a direct end-to-end anastomosis was performed between the proximal end of the graft and the common hepatic duct stump. In Patient 2, with a high hilar Strasberg E3 injury, the proximal end of the graft was spatulated—cut longitudinally and opened—to create a wider orifice. This allowed for a broad, side-to-end anastomosis directly to the confluence of the right and left hepatic ducts, a technique known as a hepatico-peritoneostomy. The distal anastomosis in both patients was an end-to-end repair to the common bile duct stump. All anastomoses were constructed using fine, interrupted 6-0 PDS sutures, ensuring precise mucosa-to-mesothelium apposition.

The final and perhaps most critical phase of the reconstruction was reinforcement. An avascular graft, such as this peritoneal conduit, is destined to fail without an external blood supply. To provide this, a robust, pedicled omental flap was mobilized, based on the right gastroepiploic artery. This is distinct from a free omental graft; the preservation of its vascular pedicle ensures it serves as an active, living source of neovascularization. The flap was passed behind the duodenum and meticulously wrapped around the entire reconstruction, covering the peritoneal tube and both anastomotic lines completely. This "omental wrap" serves two purposes: it provides the essential blood supply to promote graft survival and remodeling, and it acts as a biological seal, containing any minor initial anastomotic leak. Before closure, an intraoperative cholangiogram was performed through the T-tube, which confirmed the integrity of the repair with no evidence of contrast leakage. Two closed-suction drains were placed near the reconstruction to monitor for any postoperative leak. The total operative time for this complex reconstruction was approximately 4 hours and 40 minutes. The management of the expected initial bilious drain output, which ranged from 120-150 cc per day, was based on the concept of a "controlled anastomotic leak." This phenomenon is viewed not as a complication, but as a normal physiological event

during the graft's initial sealing phase. The leak is considered "controlled" provided the patient remains clinically stable without signs of peritonitis and the drain output shows a consistent downward trend. A failure of the output to decrease over 5-7 days, or an output exceeding 300 mL per day, would have been an indication for further investigation into a technical failure of the repair. In both our cases, the output steadily declined, indicating successful graft integration.

3. Discussion

This report describes the feasibility of a novel surgical technique for the management of complex, post-cholecystectomy bile duct injuries. The successful reconstruction of Strasberg-Bismuth Type E1 and E3 injuries using a tubularized autologous parietal peritoneal graft in our two patients offers a compelling, albeit preliminary, proof of concept for a physiology-preserving alternative to the conventional bilioenteric anastomosis. The favorable outcomes observed at 12 months, characterized by clinical recovery, biochemical normalization, and radiological patency, suggest this approach warrants further investigation.[11]

The success of this technique is predicated on the unique and dynamic biological properties of the peritoneum. The parietal peritoneum is not merely an inert patch material; it functions as a living, biologically active scaffold capable of inducing and guiding tissue regeneration.[12] The key to its function lies in the single layer of pluripotent mesothelial cells lining its surface. These cells can undergo epithelial-to-mesenchymal transition (EMT) and transdifferentiation, processes fundamental to wound healing and tissue repair. When fashioned into a conduit and placed in the biliary tract, the peritoneal graft provides the necessary physical framework upon which "biliary neogenesis"—the formation of a new bile duct segment—can occur. The inclusion of the underlying transversalis fascia during harvest is a critical technical point, as it provides the necessary tensile strength and structural integrity to prevent early graft dissolution or late aneurysmal dilatation.[13]

Based on our clinical observations and existing experimental data, we propose that the integration and remodeling of the peritoneal graft into a functional "neoduct" occurs over several overlapping phases. (1) Phase I: The Inflammatory and Sealing Phase (Days 0-7): Immediately upon implantation, the graft incites a localized inflammatory response. A fibrin matrix rapidly deposits on its surface, creating an initial, albeit imperfect, seal. This likely explains the "controlled leak" observed postoperatively; bile initially weeps through the porous graft and suture lines until this biological seal is fully established. The leak resolves as the fibrin matrix organizes and the graft begins to integrate with the surrounding tissues; (2) Phase II: The Proliferative and Migratory Phase (Weeks 1-4): This phase is characterized by cellular activity. We hypothesize that cholangiocytes from the healthy, debrided edges of the native bile duct stumps recognize the graft as a scaffold and begin to migrate across its luminal surface. The inward-facing mesothelial cells of the graft may play a crucial role here, potentially secreting growth factors and extracellular matrix proteins that facilitate this epithelial migration and proliferation; (3) Phase III: The Angiogenic Phase (Weeks 2-6): Avascular grafts are destined to fail from ischemic necrosis. The viability of the peritoneal conduit is therefore entirely dependent on rapid and robust neovascularization.[14] This is the critical role of the pedicled omental flap. The omentum is a rich source of angiogenic growth factors, such as vascular endothelial growth factor (VEGF) and fibroblast growth factor (FGF). By wrapping the omentum around the reconstruction, we provide a direct source of neovessels that invade the graft, ensuring its survival and facilitating the subsequent remodeling process. Animal models have shown that peritoneal grafts demonstrate supportive trends in angiogenic markers, reinforcing this mechanism; (4) Phase IV: The Remodeling and Maturation Phase (Months 2-12+): Over an extended period, the graft undergoes complete remodeling. The migrating cholangiocytes eventually form a confluent, mature

biliary epithelium on the luminal surface, effectively transforming the peritoneal scaffold into a new segment of bile duct.[15] The connective tissue of the graft is remodeled, and the entire structure becomes a seamless, integrated conduit. The absence of stricture on 12-month MRCP in our patients suggests that this healing process occurs without the excessive, disorganized fibrosis that typically plagues biliary anastomoses. This favorable healing may be due to the immunomodulatory properties of the peritoneum, which could dampen the chronic inflammatory response that drives fibrotic stricture formation.

The primary advantage of this technique over RYHJ is the preservation of the sphincter of Oddi.[16] This maintains the regulated, physiological flow of bile into the duodenum, which is crucial for normal digestion and absorption of fats. It also prevents the reflux of intestinal contents into the biliary tree, theoretically avoiding the long-term risk of reflux cholangitis, a major cause of morbidity after RYHJ. Furthermore, the entire biliary system remains endoscopically accessible for any future interventions, an option that is permanently lost after a Roux-en-Y reconstruction. The graft material itself is a major advantage: it is completely autologous, readily available from the same surgical field, and its harvest adds minimal operative time and no donor site morbidity.[17] These principles are supported by recent reports, including a systematic review on the use of peritoneum for vascular reconstruction, which found high success rates, and a case report by Barakat and colleagues describing a similar successful repair of a proximal hepatic duct transection.

While our initial results are encouraging, it is imperative to consider the potential modes of failure for this new technique. The most significant concern is the long-term durability of the "neoduct." If the neovascularization from the omental wrap is insufficient or fails, the graft will become ischemic and necrose, leading to a catastrophic breakdown of the repair and uncontrolled biliary peritonitis.[18] This underscores the critical importance of creating a well-vascularized, tension-free omental wrap. The most common failure mode for any biliary reconstruction is stricture. While we hypothesize that the peritoneum promotes favorable healing, it is conceivable that in some patients, the remodeling process could be dominated by myofibroblast activity, leading to graft contracture and the formation of a long, tubular stricture that would be difficult to manage. The mild biliary dilatation seen on follow-up imaging, though stable and clinically insignificant in our patients, must be monitored closely as it could be the earliest sign of an evolving obstruction. The peritoneal conduit lacks a true muscularis layer like a native bile duct.[19] Over many years, it is theoretically possible that the graft could slowly dilate under the pressure of bile flow, leading to an "aneurysmal" segment with bile stasis and potential stone formation. The newly formed epithelial surface, even if complete, may not possess all the properties of native biliary mucosa, such as mucin production. This could make the surface of the neoduct a potential nidus for the formation of biliary sludge or stones over the long term.[20]

This report must be interpreted with significant caution. Its primary and most profound limitation is the sample size of two patients. This study design is a descriptive report of a preliminary experience and sits at the lowest level of the evidence hierarchy. The results are anecdotal and cannot be used to determine safety or efficacy. There is a high risk of selection bias, although we report our only two consecutive cases.[21] Furthermore, the findings from a single tertiary center with specific surgical expertise may not be generalizable to other settings. The 12-month follow-up period is insufficient to assess long-term durability, particularly regarding the risk of late stricture formation, which can occur many years after surgery.

4. Conclusion

This report details the surgical technique and early outcomes for the repair of Strasberg-Bismuth Type E1 and E3 post-cholecystectomy bile duct injuries using a tubularized autologous parietal peritoneal graft. The technique was surgically feasible and was associated with excellent clinical, biochemical, and radiological

outcomes at 12-month follow-up in these two patients. By preserving the natural continuity of the biliary tract, this novel approach offers the potential to avoid the physiological disadvantages and long-term complications associated with a Roux-en-Y hepaticojejunostomy. However, the anecdotal nature of these findings cannot be overstated. The true safety, efficacy, and long-term durability of this technique are unknown. The autologous peritoneal graft represents a promising concept that warrants serious and methodical investigation. Larger, prospective multi-center studies with rigorous long-term follow-up are essential to establish its ultimate role, if any, in the armamentarium of the hepatobiliary surgeon for managing complex iatrogenic bile duct injuries.

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